TRANSACTIONS

OF

THE AMERICAN SOCIETY

OF

HEATING AND VENTILATING ENGINEERS

VOL. XVII

SEVENTEENTH ANNUAL MEETING

NEW YORK, JANUARY 24-26, 1911

SUMMER MEETING

CHICAGO, ILL., JULY 6-8, 1911

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AT THE OFFICE OF THE SECRETARY
NEW YORK CITY

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THE AMERICAN SOCIETY

OF

HEATING AND VENTILATING ENGINEERS.

SEVENTEENTH ANNUAL MEETING.

New York City, N. Y., January 24, 25, 26, 1911.

PROCEEDINGS.

First Day—Afternoon Session.

(Tuesday, January 24, 1911.)

The meeting was called to order at 3.47 P.M. by President J. D. Hoffman.

Secretary Mackay read the following names of the members elected since the last meeting.

Richard W. Alger	Member.
Alfred O. Blackman	"
Alexander S. Cameron	"
William A. Cameron	"
Frank Irving Cooper	"
Albert H. De Lanney	"
Charles F. Eveleth	"

Frederick A. Forgee	Member.
Harry Geiser	"
Louis A. Harding	"
W. J. Haynes	"
E. L. Hogan	"
Aurelius E. Humphreys	"
Henry H. Humphrey	"
Charles Kausen	"
Fred A. Leland	"
Robert Lemmy	"
Martin J. Lide	"
William H. Marshall	"
Joseph A. Moore	"
Glenn C. Morgan	"
Chouteau Edward Pearce	"
E. B. Perrine	"
Fred W. Powers	"
Herbert H. Rosenbaum	"
A. H. Schroth	"
Cuthbert Schaefer	"
Perry West	"
Frank D. Windell	"
William Mayer, Jr.	Junior.

On motion the roll call was dispensed with.

On motion the reading of the minutes of the previous meeting was dispensed with.

President Hoffman: It becomes my very great pleasure to welcome you to the meeting to-day, the Seventeenth Annual Meeting of the Society. I do so with no little hesitation as to whether I will be capable of doing my part, but with a feeling of pleasant anticipation that we will have a very satisfactory and wholesome meeting.

The President then read his annual address as follows:

PRESIDENT'S ADDRESS.

As President of the Society, it gives me great pleasure to welcome you upon this occasion to our seventeenth annual meeting. The motives that men have for thus gathering them-

selves together are threefold. Collectively, they wish their Society to benefit by their presence and advice. Individually, they hope to profit by their membership and wish to become more proficient in their chosen profession. In addition, they are prepared to enjoy the sociabilities and friendships let loose upon such occasions. I trust that your ambitions for the advancement and welfare of this Society and for your own personal improvement may be fully realized, and, with like emphasis, trust that the spirit of good fellowship will prevail throughout the meeting. Ambitions such as these we have just mentioned are legitimate and are a desirable asset in the make-up of any man. Fundamentally our ambitions may have a slight coloring of selfishness, but this is all the more appreciated when personal gain is sacrificed for the good of the number. The *human* atoms that unite to form an organization are very much like the elemental units that compose *any* substance. When taken alone each part shows properties strictly characteristic of itself, but when a number of these parts are drawn together they lose their identity and blend together to give tone to the composition. Harmony is not obtained except through dissimilarity, but the purest of harmony needs little of this. The musician occasionally throws into his composition a slight discord, immediately changing to one of harmony, so that the attention is directed to the pleasing change, which is thus made all the more striking to the hearer. The artist plans his picture so that all parts point to one central idea, which is thus made prominent and unifies the whole. The harmony of color upon the canvas is produced by the happy blending of primary colors, each of which is very unlike the rest. We obtain beauty in all phases of life, in large measure, by friendly contrast. The composite thus produced has a general appreciation, because it has a flavor of all its component parts without having any one part unduly emphasized. Such is the true value of an organization like this.

Since last we met in this building, one year ago, considerable advancement has been made along the lines of effort for which our Society stands committed. Advanced methods for both heating and ventilation have been proposed and executed, and a healthful agitation for better things has been very noticeable. The technical press, and in fact many other papers not strictly classed as technical, have been energetic in bringing these things

before the public. The press has been our friend and we take this opportunity to make due acknowledgment.

This year, more than ever before, the *science* of the subject is regarded with greater respect; especially is this true concerning the *ventilation* of buildings. In many of our cities the schools are being studied as never before by eminent men, to learn the needs of the pupils and the best methods of supplying these needs. In some cases, as a result, new and radical measures are proposed. In many of these investigations no expense is being spared by the city governments in obtaining the facts. All of which goes to show the increased importance of the subject in the municipality.

One of the most far-reaching influences in this campaign for pure air is the united effort of certain State branches of the American Medical Association and the American Society of Heating and Ventilating Engineers to advocate legislative regulation for the heating and ventilation of lofts, shops, auditoriums and the like. The results of this united action are found in some of the bills for compulsory legislation, to be acted upon by the legislatures this winter. We are pleased that the position taken by our Society in the past has appealed to the Medical fraternity to the extent that they co-operate with us. We trust that the relationship between the organizations may be strengthened and that this unity of interests may become general all over the country.

Sizing up the proposition in an unbiased way, the following probably states the present conditions concerning the ventilation question: the need of pure air to maintain health is a cardinal principle, now accepted by everyone; the air we breathe contains many impurities, some of which should be eliminated to prepare it for breathing purposes; tests to detect these impurities are rather crude and inaccurate; present methods of supplying the air to the rooms are open to question. From this summary it would seem that a great many of the important points concerning ventilating air are still to be settled, and apparently the need for careful scientific investigation is very great. Some radical changes in the old and well-established methods of purifying, supplying and exhausting the air are being proposed. These changes should be carefully considered in comparison with our present methods, and the future practice should

be recommended accordingly. The program for this meeting was arranged with this in view, and it is hoped that we may be able to confirm the best and eliminate the bad in all our future heating and ventilating work.

Within the past year our Society has been very much alive to its opportunities and has been working faithfully. Our committeemen have been generous with their time and money in the interest of the Society, and in large measure have subordinated their individual interest for the common welfare. For this they deserve our thanks. What is here said regarding the spirit of the committeemen will, I believe, apply with equal force to the general membership, wherever the opportunity has presented itself for them to act.

At the last annual meeting there were a total of 367 members in all grades. At the time of the summer meeting, 1910, three had failed to qualify and seven had resigned, leaving 357. Of this number 14 were dropped for non-payment of dues, giving a net membership of 343 preceding the spring ballot, which added 29 new names, making a total of 372, at that time the largest enrollment in the history of the Society.

Since the summer meeting 21 members have been added to the roll, making the total list now on the Secretary's books 393, which, with 9 applications in the Secretary's hands that have not been acted upon, will probably carry us over the 400 mark.

Concerning our finances, we have in round numbers $1,267 on hand, which, with delinquent dues and dues from new members that have not yet been paid amounting to $1,400, makes a total of approximately $2,667 to our credit. I trust that all members who are in arrears with their yearly dues will pay the amount promptly and give the Society a freer hand in planning and accomplishing larger things in the future.

Finally, as your presiding officer, I wish to congratulate the membership upon the advancement that you have made during the past year.

The Secretary's report was read, and on motion was received and placed on file.

SECRETARY'S REPORT.

Gentlemen: Your Secretary would report an increase in membership during the past year. At the last annual meeting our membership was composed of 2 Honorary Members, 323 Members, 27 Associates and 15 Juniors, or a total of 367 members of all grades.

During the year we have elected 1 Honorary Member, 51 Members, 4 Associates, and 3 Juniors, while 2 Associates have been elected to full membership. Eleven Members, 2 Associates and 3 Juniors have been dropped from the roll for non-payment of dues, 5 Members and 3 Associates failed to qualify, 1 Junior was advanced to full membership, 5 Members and 2 Associates resigned, and we have had three deaths in our ranks: Mr. Walter B. Pelton, who became a Member June 24th, 1910, died November 2d, 1910; Mr. R. Barnard Talcott, who became a Member June 16th, 1899, died December 4th, 1910; Mr. William H. Bryan, who became a Member July 15th, 1898, died December 8th, 1910. A letter of condolence was sent by the Secretary to the family of each deceased member.

Our present membership is 3 Honorary Members, 352 Members, 21 Associates and 14 Juniors, or a total of 390 members of all grades, a net increase of 23.

Our financial affairs are in a good condition; at the last annual meeting there was a balance of $1,212.68 in the treasury; during the year we have received $4,324.10 from all sources; this, with the balance on hand, making a total of $5,536.78. The total expenditure for the year amounted to $4,269.83, leaving a balance of $1,266.95 in the Treasury.

There is owing to the Society, from members for dues and from newly elected members for initiation fees, $1,322.85; this with the balance on hand amounts to $2,589.80. The members dropped from the roll during the past year for non-payment of dues owed the Society $400.00. Five candidates for membership and 3 for associate membership elected during the year failed to qualify.

The Secretary's expenses for the year, including stenographer, clerk hire, post office box, expenses in connection with the summer meeting, postage, express, telegrams, telephone, office rent, etc., amounted to $1,374.48.

The Society held a summer meeting at St. Louis, Mo., June 30th and July 1st, 1910, which was largely attended and successful in every way.

The 1908 proceedings were completed and forwarded to the members during the year. The 1909 proceedings were delayed in editing, but are now being printed and will be forwarded to the members as soon after this meeting as possible. The 1910 proceedings are in hand, and there is every hope that they will be completed during the year.

The 1910 directory was delayed on account of a number of candidates elected on the May ballot failing to qualify, and also on account of a number of the members neglecting to send in their corrected slips, the Secretary having to furnish over 150 addresses and occupations, but the directory has finally been issued in as complete a form as possible and mailed to the members.

The papers and reports for this and the summer meeting were received late, but were printed and sent to the members as far in advance of the meetings as possible, except a report received on the 21st inst., which is being printed and will be received to-day.

The Secretary has 9 applications for membership on hand. This will ensure a ballot being sent out soon after this meeting.

The Secretary would request the members to notify him promptly of any change in their address, as he finds that, on account of lack of notification, mail is frequently sent to an old address for months, with delay in correspondence with the members, and sometimes is returned to the Secretary, necessitating correspondence with some member in that vicinity before obtaining a correct mailing address. All this would be avoided and the members more promptly served if the Secretary were notified of any change in their address.

Respectfully submitted,

WM. M. MACKAY,

Secretary.

The Treasurer's report was read by the Secretary, and on motion was received and referred to the Auditing Committee.

The report of the Board of Governors was read by Mr. Bolton, and on motion was laid on the table for discussion later.

REPORT OF THE BOARD OF GOVERNORS.

New York, January 24th, 1911.

Gentlemen: Your Board of Governors met and organized January 20th, 1910, appointing Committees on Finance, Membership and Publication, and an Executive Committee. The various committees have given careful attention to their duties and the Board has met six times during the year.

A proposed amendment to the constitution, regarding amendments, was received and sent out for a vote of the membership. One hundred and forty-seven votes were cast, 138 being in favor of, and 9 against the amendment, which was declared carried and in force, as reported at the summer meeting.

A successful summer meeting of the Society was held at St. Louis, Mo., June 30th and July 1st, 1910.

The Society has in storage 1,257 copies of its proceedings, volumes 2 to 13. The Society carries $1,000 insurance on its property in the Secretary's office, consisting of a Remington machine and desk, book-case, book shelves, two cut cabinets, 6 tin lined cases for proceedings, 16 volumes Mechanical Engineers Transactions, 18 volumes Electrical Engineers Transactions, 18 volumes Civil Engineers Transactions (not bound), 13 volumes Brooklyn Engineers Club Transactions, 48 monthly issues Engineering Magazine, 84 monthly issues Insurance Engineering, 34 issues American Institute of Architects Proceedings, 58 issues Western Engineers Society Proceedings, 36 issues Engineers Club of Philadelphia Proceedings, the Society Proceedings, 200 copies, vol. 2 to 13, 185 copies of vol. 1 and 150 copies of vol. 14, also a number of pamphlets and advance papers presented at the Society meetings and available to the members, 2 solid gold and 18 gold-plated pin badges.

The Society directory was delayed on account of some of the members on the May ballot failing to qualify and many members failing to furnish necessary corrections. It has now been issued and mailed to the members.

The Membership Committee passed on 65 applications for membership during the year.

While we have lost more members during the past year through suspensions, resignations and deaths, our membership is larger than ever before, with indications of a large increase

during the coming year, while the financial affairs of the Society are in a prosperous condition.

Respectfully submitted,

James D. Hoffman, Chairman,
Reginald P. Bolton, Vice-Chairman,
Samuel R. Lewis,
R. C. Carpenter,
James Mackay,
Judson A. Goodrich,
John F. Hale,
George W. Barr,
Wm. M. Mackay, Secretary.

President Hoffman: We will now call for the report of the Committee on Legislation.

The report of Committee on Legislation read by Mr. Hale.

REPORT OF COMMITTEE ON COMPULSORY LEGISLATION.

In searching through the proceedings of this Society preparatory to making the review report on Compulsory Legislation, the chairman of this committee found that comparatively little interest had been taken in the matter up to that time, and although laws have been enacted in several States and regulations have been set forth in many cities relating to the ventilation of schools, the subject seemed to be looked upon lightly.

Within the last few years the engineers, physicians and educators the country over have been aroused to the realization that the subject of ventilation in all classes of buildings is one of vital import, and you have but to read the public press to see how deep seated this conviction is.

In Chicago a commission was appointed by the Mayor, consisting of a member of the Board of Education, the Director of Laboratories and the Chief Commissioner of Health, these three to co-operate with a committee appointed by the Illinois Chapter of this Society, and these six men are known as the Chicago Ventilation Commission, upon whom has been placed the arduous task of determining, first, what constitutes perfect ventilation, and, second, how to accomplish the desired results. This com-

mission has met week after week throughout the year, and as a result of its labors has made a report, which forms a chapter in the book, published by the United Charities of Chicago, entitled "Open Air Crusaders," and has been active in the framing of a new building code for the city of Chicago. Awaiting the report of the Chicago commissioners, we have made no attempt to frame a ventilation law for presentation to the Legislature, although this is the next thing to be accomplished, and the committee for 1911 should see to it that something is done before the end of the present session.

It is true there is a factory law now in effect in Illinois that relates to ventilation, but this does not cover school houses or other public buildings, which we are particularly interested in. Your President and a member of this committee went before the State Medical Society of Indiana, in September last, and interested them to such an extent that they passed a resolution, giving the President power to appoint a committee to work with our committee, towards the enactment of a Compulsory Ventilation law, and we are pleased to state that a bill has been prepared and will be introduced in the present Legislature, and we have every reason to believe that it will become a law.

From Colorado we hear that they are hopeful that the bill presented at the last Legislature will be passed during this session, and a similar report comes from Wisconsin members interested in the Society's affairs. From California we hear that they are now preparing a bill for presentation shortly, and in both Delaware and Maryland active steps are being taken in the interest of State ventilation laws. From all parts of the country comes the question regarding the ventilation of small places of amusement, commonly known as "Nickel Shows," and these places should be specifically mentioned in any State laws enacted or municipal regulation set forth.

Among others who have brought this to our attention is Professor P. F. Walker, of the University of Kansas, who is interested in a ventilation law in his State, and with the assistance of our local members something should be accomplished.

A letter from the Hon. Wm. J. Price, of Fargo, N. D., states that he is now working upon a bill based upon information given by your committee, and he hopes to have a law enacted by the Legislature now in session. Information has been given certain

members in Nebraska, based upon which a bill is in preparation and will probably be submitted to the present Legislature.

A bill was prepared for the State of Michigan, but it did not come up at the last Legislature. We are pleased to report, however, that the local member of this committee has the matter well in hand, and, with the co-operation of both the local (i. e., Detroit) and the State Board of Health, has every reason to believe that a law will be passed during the present session of the Legislature.

During the last session of the Ohio State Legislature, House Bill No. 258 was passed, wherein the State Board of Health, the State Fire Marshal and the Chief Inspector of Workshops and Factories were empowered and directed to cause to be prepared and submitted to the next session of the General Assembly a code of regulations with respect to the construction, safety, sanitary conditions and maintenance of public and other buildings.

The committee, who have been at work upon this code, have just reached that part relating to heating, ventilating and sanitary conditions, and have placed this matter in the hands of Mr. Fred W. Elliot, an architect of Columbus, Ohio. One of the members of our publicity committee has been in close touch with the situation in the State of Ohio, and reports that Mr. Elliot will be sent east shortly to look into the subject, and it has been suggested that the Society pass a resolution offering our co-operation in the preparation of this State Code and that arrangements be made to meet him upon his eastern trip and extend to him every assistance possible.

At the summer meeting this committee made a preliminary report in which attention was called to the state of affairs existing in Massachusetts, and recommended that a special committee on Compulsory Legislation be appointed for that State, to work in conjunction with the present committee, and recommendations were made as to who should be included in this sub-committee, but we regret to state that no action has ever been taken.

A committee appointed by the Illinois chapter of this Society, to co-operate with the Mayor's committee, known as the Chicago Ventilation Commission, has assisted in the preparation of certain sections of the new Chicago Building Code, which has just gone into effect, and your attention is called to the following taken from the same:

ARTICLE XX.—Ventilation.

"Sec. 680. *Ventilation in Buildings of Classes IV, V, VII and VIII.*

"(a) The air in any room used as an auditorium in buildings of Class IV and V, hereafter erected, and the air in any room used as a classroom or assembly hall in buildings of class VIII, hereafter erected, shall be changed, so as to provide each person, for whom seating accommodation is provided in such auditorium, classroom, or assembly hall, with at least 1,500 cubic feet of air per hour.

"(b) In buildings of Class VII, hereafter erected, on floors frequented by the public, the air in such rooms shall be supplied at the following rates: For each person in basement, 2,000 cubic feet per hour; for each person in 1st to 3d stories, both inclusive, 1,500 cubic feet per hour; for each person in 4th story and above, except as hereinafter provided, 1,300 cubic feet per hour; for each person in grocery departments and restaurants, 1,500 cubic feet per hour.

"(c) For the purpose of determining the number of people on any floor in buildings of Class VII, in calculating the means of ventilation, the following floor area per person per floor shall be taken as the basis: Basement, per person, 20 square feet of floor area exclusive of walls, stairs and elevators; first story, per person, 20 square feet of floor area, exclusive of walls, stairs, elevators, and enclosed show windows; second story, per person, 50 square feet of floor area, exclusive of walls, stairs, elevators, and enclosed show windows; third story, per person, 60 square feet of floor area, exclusive of walls, stairs and elevators; fourth story and above, per person, 80 square feet of floor area, exclusive of walls, stairs and elevators, except as hereinafter provided.

"(d) Grocery departments and restaurants, per person, 40 square feet of floor area, exclusive of walls, stairs and elevators.

"(e) The amount of carbon dioxide in the air of any such auditorium, classroom or assembly hall or space frequented by the public in Class VII buildings shall not be permitted to rise above 10 parts of carbon dioxide per 10,000 parts of air, measurements being taken at levels from two and one-half feet to eight feet above the floor, generally distributed, and the tem-

perature in such spaces, when artificially heated, shall not exceed 68 degrees Fahrenheit. Relative humidity shall not be less than 45 degrees nor more than 80 degrees.

"(f) The air in any room used as an auditorium in buildings of Classes IV and V, constructed prior to the passage of this ordinance, and the air in any room used as a classroom or assembly hall in buildings of Class VIII, constructed prior to the passage of this ordinance, shall be changed, so as to provide each person for whom seating accommodation is provided in such auditorium, classroom or assembly hall with at least 1,200 cubic feet of air per hour.

"(g) The air in any rooms and floors in buildings of Class VII, erected prior to the passage of this ordinance, shall be supplied by mechanical or other means, at the following rates: for each person in basement, 1,600 cubic feet per hour; for each person in 1st to 3d stories, both inclusive, 1,200 cubic feet per hour; for each person in 4th story and above, except as hereinafter provided, 1,040 cubic feet per hour; for each person in grocery departments and restaurants, 1,200 cubic feet per hour.

"(h) For the purpose of determining the number of people on any floor in buildings of Class VII, in calculating the means of ventilation, the following floor area per person per floor shall be taken as the basis: Basement, per person, 20 square feet of floor area, exclusive of walls, stairs and elevators; first story, per person, 20 square feet of floor area, exclusive of walls, stairs, elevators and enclosed show windows; second story, per person, 50 square feet of floor area, exclusive of walls, stairs, elevators and enclosed show windows; third story, per person, 60 square feet of floor area exclusive of walls, stairs and elevators; fourth story and above, per person, 80 square feet of floor area exclusive of walls, stairs and elevators, except as hereinafter provided; grocery departments and restaurants, per person, 40 square feet of floor area exclusive of walls, stairs and elevators.

"(i) The amount of carbon dioxide in the air of any such auditorium, classroom or assembly hall or space frequented by the public in Class VII buildings shall not be permitted to rise above 12 parts of carbon dioxide per 10,000 parts of air, measurements being taken at levels from two and one-half feet to eight feet above the floor, generally distributed; and the temperature in such spaces, when artificially heated, shall not ex-

ceed 70 degrees Fahrenheit. The relative humidity shall not be less than 40 degrees nor more than 85 degrees.

"(j) The word "auditorium" as used in this section in connection with buildings of Classes IV and V shall be construed as including the main floor, balcony and galleries.

"(k) In buildings hereafter erected for or converted to the use of a factory, mill or workshop, the air shall be changed, except as hereinafter provided, so as to provide each person, for whom working accommodations are provided therein, with at least 1,500 cubic feet of air per hour.

"(l) In buildings used for the purpose of a factory, mill or workshop at the time of the passage of this ordinance, the air shall be changed, except as hereinafter provided, so as to provide each person for whom working accommodations are provided therein with at least 1,200 cubic feet of air per hour.

"(m) In any building or room hereafter erected for or converted to the use of a factory, mill or workshop the amount of carbon dioxide in the air, except as hereinafter provided, shall not be permitted to rise above ten parts of carbon dioxide per 10,000 parts of air.

"(n) In buildings or rooms used for the purpose of a factory, mill or workshop at the time of the passage of this ordinance, the amount of carbon dioxide in the air, except as hereinafter provided, shall not be permitted to rise above twelve parts of carbon dioxide per 10,000 parts of air. The measurements in each case above enumerated in this paragraph shall be taken at levels from two and one-half feet to eight feet above the floor, distributed generally; and the temperature in such spaces, when artificially heated, shall not exceed 68 degrees Fahrenheit, except as hereinafter provided; the relative humidity shall not be less than 40 degrees nor more than 85 degrees.

"(o) The above provisions and standards as to ventilation shall not apply to storage rooms, or vaults, or any place where the manufacturing processes therein conducted would be materially interfered with, or where manufacturing processes therein conducted would produce considerable quantities of free carbon dioxide, except that the air in such rooms or vaults, or in any places of manufacture, shall not be permitted to become detrimental to the health of those who enter or work therein.

"(p) No part of the fresh air, supplied in compliance with

the requirements of this section, shall be taken from any cellar or basement.

"(q) No person, firm or corporation, either as owner, proprietor, lessee, manager or superintendent of any factory, mill, workshop or any other building where one or more persons are employed, shall cause, permit, or allow the same or any portion or apartment of any room in such factory, mill or workshop, to be overcrowded or to have inadequate, faulty or insufficient light or ventilation.

"(r) No person shall be exposed to any direct draft from any air inlet, nor to any draft having a temperature of less than sixty degrees.

"(s) All poisonous or noxious fumes or gases, arising from any process, and all dust of a character injurious to the health of the persons employed, which is created in the course of a manufacturing process, within such factory, mill, workshop or laundry, shall be removed, as far as practicable, by either ventilating or exhaust devices."

It is gratifying to note the marked interest shown in the subject of ventilation, and the space given in the trade journals is evidence of the fact that the public is at last aroused to the need of ventilation laws. Special attention is called to the January edition of one of our prominent engineering papers, in which 14 full pages are devoted to State and Municipal laws and regulations in all parts of the country.

As stated in the report of the Committee on Compulsory Legislation for 1910, it has been impossible to show any actual State laws passed during the year, but much good has been done by keeping the subject ever before the public, and we hope that the committee for 1911 will be able to report the accomplishment which we have been striving for.

Respectfully submitted,

John F. Hale, Chairman,
Theo. Weinshank,
F. R. Still,
H. W. Whitten,
Wm. K. Downey,
H. D. Crane,
Frank E. Baker.

Mr. Chew: I move that that report take the usual course and the recommendation made by Mr. Hale be complied with. In looking through our proceedings there will be found given in a number of places the names of different trade papers and dates where such information can be found, and certainly it ought to be a convenience to see in our printed matter the name of the paper and the date of issue to which allusion is made.

The motion was seconded and carried.

Mr. Hale: In addition to that report I wish to submit a diagram or chart which has been handed to me since I have been in New York, which should really become a part of the report and also of our records. It is a chart showing where compulsory regulation of schoolhouse ventilation was in effect in the United States in 1910; it shows, in diagrammatic form, where laws have been enacted and where schoolhouse legislation is in effect, whether by State or Municipal laws.

The white sections of the diagram show where no laws are in effect, and you will note what a small portion of the country has been covered so far and the vast territory that should be covered by the next committee.

Mr. Whitten: I would say as a member of that committee that that chart was handed to me by Mr. Frank I. Cooper, who was recently elected a member, and that he would like it to become a part of this report. It was gotten up for the Research Society, and he will not be in a position to give it to the Society for some little time, perhaps a month or two, when he will be free to turn it over. It seems to me a very good diagram, and it should become a portion of our proceedings.

It was moved and seconded that the chart be made a part of the committee report and that the name of the party donating it be added. (Carried.)

President Hoffman: Next are the reports of Special Committees. Are there any Special Committees to report?

The report of the Committee on New Members was read by Mr. D. D. Kimball, and on motion the report was received and accepted.

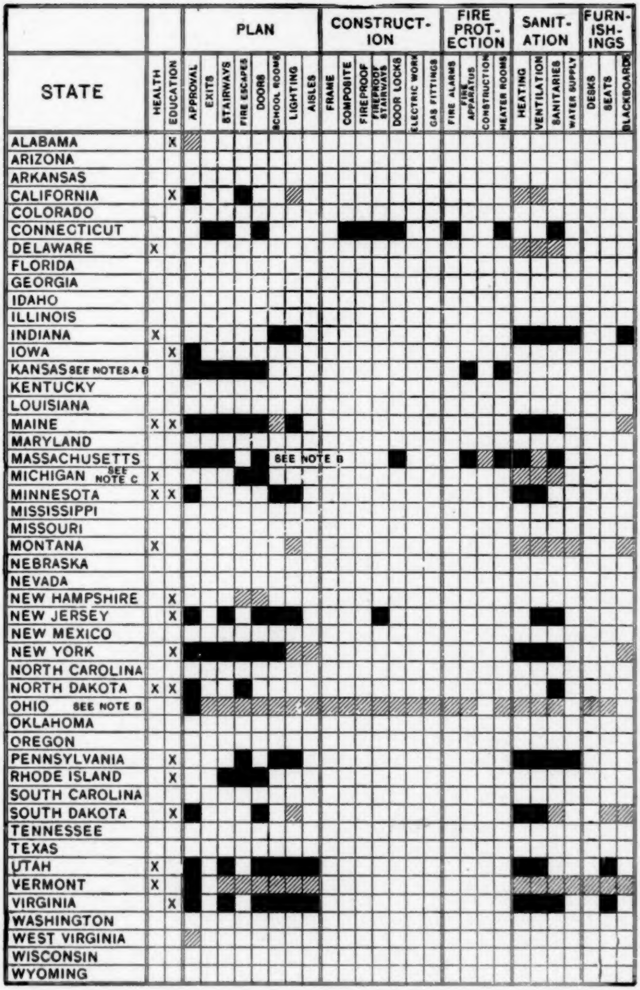


Chart Showing Status of Compulsory Regulation of Schoolhouse Construction in the United States in 1910.

X indicates department controlling the enforcement of the laws.

Note A.—The plans for school buildings in this State must be approved by State Architect.

Note B.—These rules are prepared by the Department of Inspection of Workshops, Factories and Public Buildings.

Note C.—These laws and regulations apply to State buildings only.

Full black indicates law. Hatched or section lining indicates regulation.

REPORT OF THE COMMITTEE ON NEW MEMBERS.

As Chairman of the Committee on New Members of the American Society of Heating and Ventilating Engineers, I beg to submit the following report:

The committee as appointed by the President included the following members:

D. D. Kimball, New York, Chairman.
W. M. Mackay and H. L. Doherty, New York.
W. G. Snow and E. D. Densmore, Boston.
Homer Addams, Philadelphia.
F. R. Still, Detroit.
N. S. Thompson, Washington, D. C.
T. B. Cryer, Newark, N. J.
Bert C. Davis, Kansas City, Mo.
Samuel R. Lewis, Chicago.
Theo. Weinshank, Indianapolis, Ind.
M. M. Cochran, St. Paul, Minn.
Thomas Morrin, San Francisco, Cal.
J. E. McGinness, Pittsburgh.

Because of the very wide geographical distribution of this committee, it was impossible to hold a general meeting, but so far as possible conferences have been held to discuss the work. A plan of procedure was mapped out in New York, and as a result three letters were sent out. Form No. 1 was sent to the members of the committee, as instructions for the carrying out of the campaign; No. 2 was sent out to the entire membership of the Society to interest them in the effort, and No. 3 was prepared as a letter which all members of the Society might use, so far as they would, in interesting candidates for membership. To each member of the Committee was sent a clipping from a map of the United States, to indicate the territory in which they were to work. Each member of the committee was asked to make a list of all consulting and contracting heating and ventilating engineers, who were not now members of the Society, one copy of this list to be retained and the duplicate to be sent to the Secretary of the Society as a record and a basis for future work. The members of the Committee were to see personally as many of these men as possible, and secure their signature to an applica-

tion blank if it could be obtained. Those who could not be seen were to be followed up by correspondence. Applications and form letters were sent to all members of the Committee.

It is my opinion that this is work which could be vigorously pushed to the vast benefit of the Society. I am in favor of the Society actively undertaking to increase its membership, particularly among the class of trained and experienced heating and ventilating engineers.

D. D. KIMBALL, Chairman.

The report of the Publicity Committee was read by Mr. Lewis, and on motion was received and accepted.

REPORT OF THE PUBLICITY COMMITTEE.

The committee was organized in accordance with a resolution passed at the 1909 annual meeting of the Society as follows:

"RESOLVED,—That it is the duty of the American Society of Heating and Ventilating Engineers to call the attention of the public to the necessity of adequate ventilation in all old as well as new buildings where persons congregate, such as schools, factories, halls and theatres, and that a central publicity committee of three be appointed, represented and assisted by one member from each State, whose duty it shall be to make continued and persistent efforts to educate the public mind, and to disseminate literature and information to the press, to the law-making bodies, colleges or any other organization or persons through whom it is possible that the aims of our Society toward proper ventilation may be advanced."

There are twenty-six members of the sub-committee as follows:

Alabama, F. H. Chisholm....................Birmingham
California, Thos. Morrin....................San Francisco
Colorado, H. H. Fielding....................Denver
Connecticut, W. D. Clark....................Willimantic
District of Columbia, C. R. Bradbury..........Washington
Illinois, Wm. L. Bronaugh....................Chicago
Indiana, Theo. Weinshank....................Indianapolis
Iowa, F. E. Baker....................Oskaloosa
Kansas, W. C. Bryant....................Holton
Kentucky, F. A. Clegg....................Louisville
Maryland, Henry Adams....................Baltimore
Massachusetts, J. W. H. Myrick....................Boston
Michigan, Ralph Collamore....................Detroit
Minnesota, L. A. Larsen....................Duluth
Missouri, Jas. M. Kent....................Kansas City
Nebraska, Geo. H. Wentz....................Lincoln
New Jersey, G. W. Knight....................Newark
New York, Geo. O'Hanlon....................New York

Ohio, M. L. Foote .... Columbus
Oregon, W. G. McPherson .... Portland
Pennsylvania, J. E. McGinness .... Pittsburgh
South Dakota, C. D. Symms .... Sioux Falls
Virginia, E. C. Wiley .... Lynchburg
Washington, W. L. Bowers .... Spokane
West Virginia, J. R. Shanklin .... Charleston
Wisconsin, Wm. K. Downey .... Milwaukee

A letter was sent to each member of the committee outlining the kind of publicity work that might be done, and requesting each to do his part.

At the 1910 annual meeting some five members of the publicity committee met, but little of interest transpired.

On February 7th a statement for publication was sent to the members, and was published in four trade papers and the Chicago *Tribune*. It is interesting that out of the twenty-six members of the committee an average of four acknowledgments of letters sent by the chairman were received. Evidently a more popular chairman is needed. On March 4th two articles for publication were transmitted. One, comparing the human body with a steam engine, was written by Mr. Bronaugh, the Illinois member of the committee; the other, on car ventilation, was written by the chairman, with suggestions from Mr. D. I. Cooke. On June 3d an article on pneumonia and ventilation suggested by the observations of the Chicago Health Department and written by the chairman was transmitted. On November 5th notice was sent of a lecture on ventilation by Mr. Wm. G. Snow, delivered at Cornell University.

On November 26th, hoping to have a report which might be printed, a letter was sent to each member asking him for a report of progress in his State. Responses were received from Messrs. Myrick, of Boston, Morrin, of San Francisco, and Foote, of Columbus, Ohio, showing that these members were actively at work. Mr. Morrin's letter is as follows:

San Francisco, Cal., December 1, 1910.

The American Society of Heating and Ventilating Engineers,
Chicago, Ill.
Attention Mr. S. R. Lewis, Chairman.

Gentlemen:

In re: Publicity Committee.

Replying to yours of the 26th ult., I wish to say that we are now actively engaged in California in an effort to secure the passage of the Massachusetts Law, or this law in an amended form. We are getting literature on the sub-

ject, have copies of your recent bulletin, and have asked the Warren-Webster Company to forward twenty-five copies of the Snow lecture. We have the co-operation of all contractors and engineers in this line.

Our Legislature meets after January 1st, 1911, and we shall lend every effort toward the formation and passage of a satisfactory law to this end.

Inviting and soliciting your co-operation in every possible way, I am,

Very truly yours,

THOS. MORRIN.

Two members of the Publicity Committee have served for over a year on the Chicago Ventilation Commission, representing the Illinois Chapter of the American Society of Heating and Ventilating Engineers. This commission serves without compensation, meeting every two weeks with representatives of the Chicago Department of Health and the Chicago Board of Education. Much of the work done has been elementary, in beginning at basic principles and gradually establishing a practicable standard of ventilation for buildings of different types. A copy of the preliminary report of this commission is printed in "Open Air Crusaders." The work of this body is by no means finished. Investigations into the following phases of ventilation are under way:

1st. Street cars—ventilation and devices for the same.

2d. Purification by ozone, and elimination of odors by the same.

3d. Ventilation of schools, including practical experiments with upward ventilation in a Chicago school, appropriation for which has been made by the Chicago Board of Education.

4th. Requirements for ventilation and air conditioning for department stores, particularly for sub-basement selling floors.

5th. Requirements for ventilation in buildings of particular occupation, such as best methods for printing offices, laundries, bakeries, restaurants, etc.

Attention is called to the good work done by the Bulletins of the Department of Health of the city of Chicago, sample copies of which are to be found in the scrapbook. Notice that these are sent free to those citizens of Chicago who should be benefited by them.

The Publicity Committee membership on the whole has not been remarkable for its work, but, as this is the history of nearly all committees, no especial discouragement has been felt by the central committee. They will, however, hold in lasting kindly re-

membrance those who have supported them in their rather new and extremely difficult efforts. Any newspaper will express willingness to publish our matter, provided each article is satisfactory and is given it exclusively. This is a difficult thing for us, who are not novelists, to do, and this is the reason why so few newspapers are represented in our clippings.

The retiring general committee recommends that, if possible, the new general committee be located in one city, so that they may combine efforts, and so that the time and trouble of sending all matter to the other distant members may be eliminated.

The Publicity Committee has kept in touch with the Compulsory Ventilation Committee, and has transmitted some information to the chairman of that body, and hereby tenders its acknowledgment to him for his co-operation and many valuable suggestions. At the secretary's desk will be found open for inspection by all interested a little scrap book: "Open Air Crusaders," a report of the Elizabeth McCormick open air school; a copy of Mr. Snow's lecture, above mentioned; a copy of a lecture by Dr. W. A. Evans, Commissioner of Health of Chicago; "Ventilation in the Public Schools," by Grant Smith; some of the Chicago Department of Health's Bulletins, and a copy of the recommendations of the Chicago Ventilation Commission in connection with a Chicago ventilation ordinance.

Respectfully submitted,

PUBLICITY COMMITTEE,

S. R. LEWIS,

ED. K. MUNROE.

Mr. Lewis: This was not in its entirety incorporated in the recent ordinance passed in Chicago, but I think it is well that it be on file with the other Publicity Committee scrapbook literature for this reason:

In all large cities, when congestion becomes great and buildings are built very high, the tendency is to go down into the ground as well as up in the air, as, for instance, in the Gimbel Bros. store, where there are selling floors more than one floor below the surface of the ground. After giving it very careful study for some time, and having tests made in the Gimbel building, and finding out just what the conditions are in different floors where the sunshine can never strike, where the natural winds of heaven

can never blow through and purify, the Chicago ventilation commission made a recommendation that as a matter of public policy it was opposed to the use of more than one floor below grade as a selling floor. However, should the pressure brought by the property owners to permit the use of sub-basement space be so great that its use could not be prevented, we ought to insist on very high standards, and these suggested standards are submitted to you as a matter of interest.

Mr. Chew: The original motion which brought this committee into existence was one that will give some publicity to the Society at the annual meeting; and while that was the object, I do not know that there is any occasion for those who are identified with the original motion to take exception to the excellent work that has been done by the committee. I still believe, however, that the annual meeting of this Society is too important to pass without securing more attention from the daily press than it now receives. I believe that what the newspapers call a human interest story could be prepared on every January meeting held.

Mr. Lewis: I only wish to call attention to the fact that the resolution under which this Publicity Committee was operating does not cover those points that Mr. Chew mentioned. But perhaps to cover the points he mentions another committee should be organized.

I question seriously whether there is any need of the Publicity Committee operating under any special resolution. It is very hard to separate the work of that committee from the work of the Compulsory Ventilation Legislation Committee, and I think that the merging of this committee with the Publicity Committee would be desirable.

President Hoffman: The question brought up by Mr. Lewis could be taken up as new business at the close of this meeting.

The report of the Illinois Chapter was read by Mr. Hale, and on motion was accepted and placed on file.

REPORT OF THE ILLINOIS CHAPTER.

The Illinois Chapter wishes to report that its members still continue to meet regularly during the fall and winter months, and that the interest is evidenced by the good attendance up to the present time.

At the meeting held on February 14th, 1910, our local Committee on Tests submitted a detailed report of an exhaustive test made by about fifteen of our members at the new Engineering Building at Northwestern University, Evanston, Ill. This building is heated by steam taken from the central station and includes a vacuum system attached to both the direct radiators and blast coils. In making this test, everything was recorded, including fifteen minute readings of thermometers in each room, temperatures of air at inlet and outlet of fan, speed of fan, velocity of air not only at the outlet of the fan but through the registers. Condensation was both measured and weighed and the data all reduced into form for ready reference.

The test referred to occupied almost an entire day, and the completeness of the report warrants it becoming a part of the records of this Society.

In March, 1910, an extremely interesting paper was read by Mr. Harry W. Ellis on the subject of Temperature Regulation, this beginning with a short history of the art and ending with a talk describing the difficulties met and how they were being overcome. Mr. Powers, a guest of the evening, told of his experience in this line, a long discussion following which occupied the greater portion of the meeting. Unfortunately Mr. Ellis's paper was not in such form that it could become a part of our records, and it is suggested that he be called upon by this Society to prepare a paper on the subject, to be read before one of the subsequent meetings of this Society.

At the April meeting Mr. Geo. Mehring exhibited the working plans of the palatial home of J. Ogden Armour, located at Lake Forest, Ill. This contained several unique features and was well received. Mr. John Boylston gave a talk on "Pressure Reducing Valves," illustrated by extracts from catalogs, which he passed among the members. The many forms of valves placed on the market from time to time during the last fifteen years were shown, and the speaker called attention to the troubles encountered in their use.

The members of this Society would be well repaid in reading a paper on this subject if it is possible to get Mr. Boylston to put his remarks and half tones in form for publication.

The May meeting was for the transaction of business of interest to the Chapter members only, including reports of the

various committees and the appointment of a committee to nominate officers for the present year.

The annual meeting of the Chapter took place on October 10th, 1910, twenty-two (22) members being present. The following had been elected to office for 1911:

N. L. Patterson, President,
Samuel R. Lewis, Vice-President,
John F. Hale, Secretary,
August Kehm, Treasurer.

Edmund F. Capron,
Geo. J. Phillips, } Board of Governors.
Chas. F. Newport.

The installation of new officers and the reports of the outgoing officers and committees occupied the evening.

At the November meeting we had a general discussion of the reports made from time to time by the local committees, but most of the time was taken up by the committee appointed to co-operate with the Chicago Department of Health. Few of our members realize the extent of the work done by this committee, which consists of Mr. Geo. Mehring, Mr. Samuel R. Lewis and Mr. W. L. Bronaugh, but when they learn that these joint committees have met twice and sometimes four times a month since their appointment, it will be seen that the little Chapter in the West has been very wide awake.

Owing to the death of Mr. Wm. H. Bryan, member of this Society and but recently appointed Chief Engineer of the Chicago Board of Education, the December meeting was adjourned early after passing the following resolution:

> "The Illinois Chapter of the American Society of Heating and Ventilating Engineers at its meeting held on Monday, December 12th, 1910, passed the following resolution:
>
> "Whereas, Through the wisdom of our Divine Master, our fellow member, Wm. H. Bryan, has passed beyond, and,
>
> "Whereas, Our relations and recollections of our late fellow member most vividly recall his worth, be it

"RESOLVED, That the sympathy and condolence of this Chapter be extended to the family in this their hour of sorrow, and

"That this resolution be spread upon our records and a copy be forwarded to the family as a testimonial of regret."

This resolution was engrossed in simple form and has been forwarded to Mr. Bryan's family.

On January 9th, 1911, the Illinois Chapter held an open meeting in the rooms of the Western Society of Engineers, at which we listened to an illustrated talk by Mr. L. C. Soule, member of this Society, on the subject of "Cast Iron Hot Blast Heaters."

VENTILATION IN SCHOOLS.

Reference has been made to the work of our local committee appointed to co-operate with the Chicago Department of Health, and in order that you may realize the importance of this committee's work, you will find in the following pages the joint report made by these two committees. This report has been made a chapter in a book just published by the United Charities of Chicago with funds provided through the generosity of the Trustees of the Elizabeth McCormick Memorial Fund. It reads as follows:

"School children need well ventilated school rooms. Ventilating conditions are all right in the late spring, the early summer and the early fall. Conditions are all wrong in the late fall, the winter and the early spring. As the weather gets cold the fires are started, the windows come down, the storms windows and doors are put in and the harm begins. The old stove-heated school room was very trying. The newer ventilation methods are efforts to improve conditions.

"A perfect system of ventilation is, as yet, only a matter of theory. However, with the wealth of brains and intelligence now being exercised among physicians and ventilating engineers, it is confidently hoped and expected that a practically perfect system may be produced.

"A perfect system of ventilation should, without unpleasant drafts, provide fresh air to each person, and remove immediately

all air which has been exhaled without mixing the two or contaminating the former. A perfect system should insure that the fresh air be clean, properly moist and at a uniform temperature. With such a system the volume of air necessary for each occupant would be only equal to the amount of air exhaled in an hour, a volume almost infinitesimal compared with the amount of air ordinarily pumped into an average Chicago school room.

"Physical conditions have rendered the construction of an ideal ventilating system very difficult and very expensive. For instance, every window presents a cooling surface, which, contracting the air that lies against it, causes it to fall, setting up local currents which mix the breathed and unbreathed air. Every cool wall likewise creates this current. Every radiator or pipe, with its hot surface, expands the adjacent air, causing it to rise and mix.

"Warm, fresh air entering a cooler room rises to the ceiling. Cool, fresh air falls to the floor. Warm, exhaled, foul air rises, and is apparently raised, lowered, and diffused by the various heating and cooling agencies just as is fresh air. Then there is leakage, which affects an ordinary school room tremendously. On the windowed side enough air often comes through the walls and cracks and around the window sashes of a well built room to change the entire volume of air in ten minutes. On the leeward side eddies form suction areas which cause a like volume of warm, often fresh, air to leak out.

"These considerations have, up to this time, caused nearly all ventilating schemes to be designed on the 'dilution' principle. Sometimes the heating is done by raising the air, delivered for ventilating purposes, sufficiently above the temperature desired in the rooms to maintain that temperature there without any direct heat in the rooms. Again the air is heated only to the room temperature desired and the room is warmed by heaters located in the room. Both schemes are objectionable, inefficient and expensive, because of the large volumes of air which must be handled to secure reasonable results on the dilution principle. Leakage through walls and around windows is a very serious factor with either system.

"When air is increased in temperature by the ordinary heating apparatus it is decreased in relative humidity. Where, say, 70 per cent. humidity is common at a 68° temperature in sum-

mer, and seems to be most advantageous to human development, such a humidity is never in force in an artificially heated room unless special apparatus to create it is provided. It is probably safe to say that not more than 2 per cent. of the public schools in the United States have any humidifying apparatus. The air, having been heated to about 100° and cooled to about 70° before it reaches the pupils, is superdried and seeks to obtain its proper balance of moisture, hence dust, dry throats, parched lips and a rapid rate of skin evaporation, rendering it necessary to maintain a high temperature for comfort.

"It is our opinion that ventilating engineers have wasted much effort in trying to prevent currents or drafts of air. On the other hand, they have not expended enough effort on making drafts or currents comfortable.

"In considering the comfort from air, several factors must be taken into consideration. The body heats the air which is in contact with it to about 90° F. The skin surface of the body is about 5° F. higher than this. The heat mechanism of all bodies older than the early stages of infant life is so adjusted that provision is made for loss of heat and moisture by the skin. Such loss must go on at all times, else there is discomfort.

"When the temperature of the air is below 60° F. the loss is so great that we cover the body with extra layers of low conducting, partially impervious cloth to hold the warm, moist air next the skin under the clothes. When the temperature mounts above 70° F. we remove some of this cloth and change the remainder to cloth of an open texture and greater conductivity. When the temperature mounts above 85° F., if there are no drafts, we use fans to drive the 90° F. air from around the face and next the body within the clothes.

"It has been demonstrated that if two rooms be taken, each room warm and each occupied, one having fans and the other not, the room with the fan will show more CO_2 in the breathing zone than will the other room. This is because the air which is ordinarily near the ceiling and is rich in CO_2 is blown back into the breathing zone. On the other hand, the room containing the fans will be the more comfortable because the currents blow the hot air of the aerial envelope away from the body. There is no comfort without air currents strong enough to change the air around the face freely, and to blow out the clothes frequently.

If the currents get lower than 60° F. something must be done to counteract them.

"The children in the Elizabeth McCormick Open Air School got heavy clothing and additional food and took active exercise. This is not the remedy for the average school room. There the remedy is to supply the currents heated to 60° F.

"In hot weather no clothing is cool that does not permit the hot air of the aerial envelope to blow away. In cold weather there is no comfort unless the aerial envelope blows away, but the chilling of the body surface will be too rapid for comfort unless something is done to compensate. The things which can be done are to warm the blowing air or to take more exercise.

"A second factor making for the comfort of air is humidity. A humid air chills more than a moderately dry air because the moisture of the air is a better conductor of heat than is the air itself. On the other hand, if the air is very dry, evaporation from the skin is excessive and the skin is unduly chilled if the temperature is low.

"In cold weather, then, ventilation should be done with air which is fairly humid, yet not too humid. In hot weather the body tries to cool itself by pouring out perspiration. The evaporation of this perspiration lowers the temperature of the surface from which it has evaporated. Therefore, in hot weather dry air currents are much more comfortable than wet ones.

"The comfort of currents is largely dependent upon the personal equation. Generally speaking, fat people want colder currents than lean people. Some people are naturally better heat makers than other people. They will be comfortable in colder currents than other people. Some people have trained themselves so that their heating apparatus is well developed. They have educated themselves away from the close, heavy clothing, which held the foul hot moist air of the body in contact with it. They have educated their mechanism to the point where they feel better when this air is blown away and the heat lost is made up by greater heat production. And, finally, there are many psychologic factors.

"Many of the above comfort considerations merge quite logically into health considerations. In addition to the need of currents of air blowing around the body, there is the still greater

need of currents blowing around the head. The head, face and neck need the stimulus of having air strike their skin. They need that this air should be cool. They can stand this air cooler than can the body because they have been differently trained. The main consideration, however, is that air currents should blow the expired air away from the nose and out of the breathing zone. Should we not strive to get more currents rather than fewer, at the same time trying in cold weather to temper the temperature and humidity of the currents so as to properly safeguard the comfort of the occupants of the ventilated rooms?

"Chicago has tried thoroughly in the schools that system of heating and ventilation which supplies pre-heated air to the rooms, the loss through walls and glass causing it to drop in temperature to about 70° by the time it reaches the pupil. New York has tried thoroughly in the schools the other system, in which heaters are placed in the rooms and the air for ventilation is introduced at little above the desired temperature. Both operate on the dilution principle; the principle well illustrated, perhaps, by a glass full of red ink. Try to remove the red ink by pouring in clear water. Many times the volume of ink must be displaced before the color is gone.

"The ideal system seems possible of realization only by upward ventilation, in which the air, at the desired temperature, passes upward from the breathing plane to a suction outlet, and in which the heating is a separate consideration, so handled by very ample low temperature radiation, carefully distributed, that the local antagonistic currents of the cold surfaces are eliminated. This system has to a certain extent been found practical in theatres. Its adoption in school rooms can follow only a change in the construction of these buildings, which will permit of the necessary distributing chambers under the floors, or perhaps of the necessary supply pipes in the desks.

"Any percentage of humidity may be maintained by proper regulation of the temperature of the entering air and of the water used for spraying it. Double windows may be desirable for fuel economy, and to prevent condensation on them in cold weather, due to the inside humidity. Easily operable cut-offs will be necessary in the supply and vent ducts to each room, so that when the windows are opened and the room flushed out, as is often desirable, and as a sense of cleanliness and decency seems

to suggest, it can be done without, as at present, affecting the air delivery to other rooms. At best no artificial scheme of ventilation will ever, in all probability, equal outdoor conditions in promoting human health and happiness.

"For the approximately normal children who make up the class commonly known as school children, ventilation reaching the following standards will be found satisfactory:

"*Temperature:* The temperature of the occupied parts of the school room should not be allowed to go higher than 65° F. at any time when the heat is on. The heat of the room should be approximately uniform in all parts of the room. A temperature of 60° F. is better than 65° F.

"*Humidity:* The relative humidity of the school room should be around 60 per cent. Such humidity will cause window panes to frost in all very cold weather. It can be safely assumed that the air in any room in which there are thirty people, the room having single windows which do not frost when the outside temperature goes lower than 20°, is too dry.

"*CO_2 Content:* The CO_2 in school rooms should not rise above 6 or 7 per 10,000.

"*Volume of Air:* The volume of air depends upon the principle employed in its introduction; 4,000 cubic feet per pupil per hour will be required if the foul air is perfectly admixed with the fresh air. One thousand cubic feet per pupil per hour is enough if the fresh air is fairly well protected from admixture with the foul air. A figure in between these two figures will be required according as the two kinds of air are kept separate. It is not so much the volume of air as its method of introduction that counts. If the air is introduced hot, or even warm, say over 110° F., it should be introduced high up in order to prevent its blowing fresh from the inlet to the outlet. If the air is introduced cold, without any heating, it should either be introduced high up near the ceiling or else be introduced in a current directed upward so that the force will carry it well toward the ceiling, this in order that it may be warmed before it reaches the body. Under other circumstances it should be introduced low down.

"In the language of the British Departmental Committee on Ventilation of Factories and Workshops, 1907: 'The quality of air depends on the distribution; and in many cases a relatively

small quantity well distributed is far more effective than a large quantity badly distributed.'

"*Blowing Out of the Rooms:* During the recess periods the air in the room should be blown out by raising all the windows and opening all of the doors. This lowers the bacterial count of the air of the room about ninety-five per cent. It blows out contagion of all kinds. It freshens the air, makes it bracing. It should get back to about 50° F. by the time the students come in. They have been running and playing and they will warm the room to 60° F. in a very few minutes.

"*Dust:* The dust should be kept down in the school room. This can be accomplished by good cleaning at night, say with a vacuum cleaner; by feet scrapers, to be used by the pupils before entering the room; and by keeping down the chalk dust. If the eraser is very slightly dampened before use, the blackboard dust will not be harmful. Wherever it is feasible the use of vacuum cleaning should be required by law.

"*Light:* The school rooms should be long and narrow, in width not over twice the height of the top of the window from the floor. The light should so fall as to protect the eyes of the pupils.

"*Apparatus:* The ventilating apparatus should be of such a type as to be readily adaptable to rapid changes in wind and weather.

"The effect of lack of fresh air is especially brought out by the following extract from the May 14 (1910) Bulletin of the Chicago Department of Health: 'The continuation of the unseasonably low temperature has delayed the free opening of homes, and as a consequence our pneumonia death rate continues high for this season. The deaths from pneumonia during the week just closed reached 137, 13 higher than in the preceding week and 23 in excess of the record of the corresponding week of last year. Those of our citizens who are keeping the windows of their living and working places open are in no danger—all others are.'

"The effect of the installation of reasonably efficient devices for insuring ventilation is shown by Prof. Winslow, of the Massachusetts Institute of Technology, in a paper on 'The Cash Value of Factory Ventilation,' in which he mentions that: 'Efficient production requires skilled and practical workers, in good physical condition, applying themselves with energy and en-

thusiasm to their tasks. Irregularity of attendance and the physical sluggishness and nervous inattention which accompany lowered vitality mean direct money loss to the employer of labor, as well as a burden on the community at large.'

"As an example showing the results of improved ventilation, the paper calls attention to the operating room of the New England Telephone and Telegraph Company in Cambridge, Mass., a long room having a capacity of 30,000 cubic feet, extending from the front to the back of a business block. Fifty or sixty women are employed in this room as operators. During the warmer months no difficulty has ever been experienced in ventilating the room by means of large windows at each end, and by the use of electric fans. In the winter time, however, it was impossible to secure adequate natural ventilation without undue exposure to drafts. In the spring of 1907 a simple but efficient system of artificial ventilation was installed. A marked improvement in the comfort and general conditions of the operators followed this change, and the betterment was sufficiently marked to show itself notable in the greater regularity of work. Statistics collected and tabulated showed that prior to the installation of the ventilating system for the three winter months, January, February and March, inclusive, 4.9 per cent. of the force were absent in 1906, and 4.5 per cent. in 1907. With the ventilating system in use, the absences for the same months in 1908 fell to only 1.9 per cent., a striking reduction.

"And the following from a paper by Mr. William G. Snow: 'In certain buildings where the results of changing from poor to good ventilation have been carefully observed, a marked improvement in the general health of the occupants has been manifest. For example, the records of the United States Pension Bureau show that, when the offices of the department were located in scattered and poorly ventilated buildings, 18,736 days were lost by employees through illness in one year, and about the same number for several successive years. When the department became established in its new well-ventilated quarters, the loss was reduced to 10,114 days' absence on account of illness, the working force being larger and the work increased. The gain effected is not to be measured alone by the days' absence saved, but by the greater vitality and efficiency of the entire working force. In the Boston City Hospital good ventilation is

said to have given reductions in death rate from 44 per cent. to 13 per cent. in surgical wards, and from 23 per cent. to 6 per cent. in other wards.'

"There are compulsory ventilation laws in few States. They are not uniform, and some of their provisions are impracticable. The moral effect of such laws, however, is excellent, and great progress is being made. Only six States have ventilation laws for school buildings. Two, however, have State Board of Health regulations covering the same effect. Three have bills pending and in eight States the matter is being agitated.

"Recognizing the harm which is being done by bad air, the American Society of Heating and Ventilating Engineers, the Chicago Public Schools, and the Chicago Health Department have appointed a commission for study. This commission knows that much harm is done by pollution of the outside air, but this is beyond their province. Of the harm which is done by bad ventilation, part comes from lowering the vital tone and part comes from air-borne infections. Some part of the harm which comes from lowering of vital tone makes itself manifest in infections which otherwise would not have occurred. Lowering of the vital tone is listlessness, sleepiness, mental heaviness and slowness, gaping, drowsiness, paleness, headache, anemia, laziness, enlarged glands, mouth breathing, snuffling, disposition to catch cold. The air-borne infections are pneumonia, colds, consumption, influenza, some of the scarlet fever, diphtheria and smallpox. It is more important that the people should have tempered pure air than that they should have tempered pure water.

"This commission is still at work. The method of procedure is to have members submit principles and methods of ventilation. By methods is meant basic methods. They do not consider devices or apparatus. When discussion has been as complete as is desired, and the members are ready for a conclusion, a proposition is put to a vote. So far fourteen basic principles have been unanimously agreed on. Others are still under discussion.

"Those first discussed are basic principles of ventilation. In the main they are hygienic. Those under discussion in the main are more concrete and relate more particularly to the mechanical side of the question.

"The following are the principles upon which agreement has been reached:

"1. Resolved, that carbon dioxide in the amount present in ordinary expired air does not settle out from a mixture of air and CO_2.

"2. Resolved, that carbon dioxide is not the agent of pollution of major importance in expired air.

"3. Resolved, that a temperature of 68 degrees Fahrenheit with a proper relative humidity is the proper maximum temperature for rooms artificially heated and ventilated.

"4. Resolved, that in the present state of knowledge it is impossible to designate the particular harmful agent or agents in or associated with expired air.

"5. Resolved, that large quantities of CO_2, more than 10 per cent., when long continued, are capable of producing some harm to the human body when inhaled, regardless of the source of gas, provided the oxygen percentage is not greater than in ordinary air.

"6. Resolved, that it is cheaper to heat and move air enough for adequate ventilation by currents than it is by dilution.

"7. Resolved, that, neglecting humidity, the sum total of heating agencies in a room with stationary temperature is equal to radiation by the walls, ceilings, and floors, plus the heat lost with the outgoing air.

"8. Resolved, that upward ventilating currents of air in crowded rooms are desirable when arising from sources free from dust or other injurious particles.

"9. Resolved, that in those industries where considerable CO_2 is liberated in the process of manufacture, CO_2 is not a proper standard of air pollution.

"10. Resolved, that the delivery of a certain volume of air per hour per inhabitant in a given space does not necessarily constitute ventilation.

"11. Resolved, that in cold weather it is not possible to ventilate an occupied room in this climate except with air previously warmed.

"12. Resolved, that heating and ventilating are separate questions and should always be so considered. When efforts are made to amalgamate them it should be borne in mind that there are parts of them that can not be amalgamated and must be kept separate.

"13. Resolved, that relative humidity is one of the most

important factors in ventilation from the standpoint of health.

"14. Resolved, that it is economic from a fuel standpoint to maintain a fairly constant relative humidity in ventilation.

"CHICAGO VENTILATING COMMISSION,
GEO. MEHRING,
W. L. BRONAUGH,
S. R. LEWIS,
Representing Illinois Chapter, American Society Heating and Ventilating Engineers.
PROF. F. W. SHEPHERD,
Representing Board of Education of Chicago.
F. O. TONNEY, M.D.,
Director of Laboratories.
W. A. Evans, M.D.
Commissioner of Health, Representing Department of Health."

In addition to the foregoing, the above Committee assisted in the drafting of article 20, Chicago Building Ordinance for buildings in Classes IV, V, VII and VIII, which is given complete in the report to be made at this meeting by the Committee on Compulsory Legislation.

You may find in the reports made by the committee appointed to co-operate with Dr. Evans that there are statements made which are not exactly in accordance with past practice, but are contrary to generally accepted theories, and the members of the Illinois Chapter are not a unit in the acceptance of the report.

It is believed, however, that the committee has given us something to think over and discuss, which may perchance cause members in other parts of the country to look more deeply into the subject, and by united effort finally arrive upon a basis on which we can all stand.

Respectfully submitted,
ILLINOIS CHAPTER,
John F. Hale, Secretary.

Chicago, January 21st, 1911.

APPENDIX.

Test of heating system, consisting of combination fan blast and direct radiation, in Swift Engineering Hall, Northwestern University, Evanston, Ill.

General Data.

FAN. Sturtevant 140″ × 4′ — 0″ double discharge fan, 84″ wheel, rating 22,000 cubic feet per minute at 131 r.p.m. and 0.25 oz. pressure, requiring 4.5 theoretical horse-power; actual power used during test = 3.5 kw. = 4.69 h.p. Cost of power = 8 cents per kw. hour = 5.97 cents per h.p. hours. Size of fan pulley = 48″ × 6.5″.

MOTOR. General Electric, 15 h.p., 220 volt, 3 phase, a. c., 1,200 r.p.m., size of motor pulley 5″ × 9″; width of belt 6″.

RADIATION. Indirect radiation, 2 banks, 3 sections each, total, 1,100 sq. ft.; direct radiation, cast iron, 2,707 sq. ft.; direct radiation, uncovered mains, 618 sq. ft.; direct radiation, total, 3,325 sq. ft.

Note. During test one section of indirect radiation was cut out leaving $\frac{5}{6}$ × 1,100 = 916 sq. ft. in operation.

METERS. Motor No. 1—Direct radiation; motor No. 2—indirect radiation.

BUILDING. Cubical contents, 183,439 cu. ft.; exposed wall, 11,729 sq. ft.; glass, 3,578 sq. ft.

CALIBRATION OF METERS. No. 1—Actual weight of water, 777 lb. Meter, 735 lb. Error, 5.71%. No. 2—Actual weight of water, 522 lb. Meter, 500 lb. Error, 4.4%.

Results Indirect Radiation.

Area of fan inlet (net) = 2,577 sq. in. = 17.89 sq. ft.

Velocity of air at fan inlet = 1,000 ft. per min.

Velocity of air at registers, 640 ft. per min.

Actual volume air discharged per min., 17,890 cu. ft.

Temperature of air leaving fan, 90 deg. F.

Temperature of air at inlet of coils, 29 deg. F.

Diff. in temperature entering coils and leaving fan, 61 deg. F.

Weight of air at 90 deg. = 0.0723 lb. per cu. ft.

Lbs. of air per min. discharged by fan = 17,890 × 0.0723 = 1,293.

Specific heat of air = 0.2379.

TEMPERATURE IN ROOMS

Time	First Floor							Second Floor							
	Outside Temp.	Room 111	Main Ent. Hall	Hyd. Lab.	Room 101	Room 11	Room 31	Read. Room	215	214	213	216	212	Library	231
4:30	29	68	70	70	74	68	68½	66	67	72	70	72	71	72	70
4:45	29	69	70	70	76	68½	70								
5:00	29	69	71	70	77	68½	70½	69	71	73	73	73	71	73	71
5:15	29	70	71	72	77										
5:30	29	72	72	72	78			71	72	74	74	78	76	74	72

Time	Third Floor					Fourth Floor	Basement				
	Drf. Room	322	321	311	301	North Side	Room 11	31	Hall	Steam Pres. Main	Vacuum at Pump
4:30	68	64	70	71	71	64	68	68½	64	1.25	7.50″
4:45							68½	70	64	1.25	6.00″
5:00	71	65	70	72	71	70	68½	70½	64	1.25	7.00″
5:15									64	1.25	6.00″
5:30	72	68	72	74	74	71	70	72	64	1.25	6.00″

WATER PASSING THROUGH METERS (LBS.)

Time	Meter No. 1	Meter No. 2
4:30	0	0
4:45	105	275
5:00	112.5	272.5
5:05	165	
5:10	85	
5:15	62.5	272.5
5:20	72.5	
5:25	60	
5:30	57.5	260
Total	720.00	1080.00

Total water through No. 1 meter (meter reading) 720 lb.
Total water through No. 1 meter (corrected) 761 lb.
Total water through No. 2 meter (meter reading) 1080 lb.
Total water through No. 2 meter (corrected) 1128 lb.

NOTE.—From 4:30 to 5:00 the Johnson Service System of control was in operation, and from 5:00 to 5:30 this was cut out.

Heat required to raise air to 90 deg. $= 1,293 \times 0.2370 \times 61 = 18,763$ B.t.u.

Latent heat of steam @ 1.25 lb. gauge = 963 B.t.u.

$$\frac{18,763.}{963} = 19.48 \text{ lbs. steam required per min.}$$

$19.48 \times 60 = 1,168$ lbs. steam required per hour.

Actual steam condensed per hour by meter reading (corrected), 1,128 lbs.

Sq. ft. radiation in operation in blast coil = 916 sq. ft.

$$\text{Steam condensed per sq. ft. per hour} = \frac{1,128}{916} = 1.23 \text{ lbs.}$$

Results Direct Cast Iron Radiation.

Total steam condensed per hour (corrected meter reading) = 761 lbs.

Direct radiation, cast iron = 2,707 sq. ft.

Direct radiation, cast iron and uncovered mains, 3.325 sq. ft.

Steam condensed per sq. ft. cast iron radiation per hour, including

$$\text{condensation in mains} = \frac{761}{2,707} = 0.281 \text{ lb.}$$

$$\text{Steam condensed per sq. ft. of total radiation per hour} = \frac{761}{3.325}$$

= 0.228 lb., including uncovered mains.

Respectfully submitted,

J. M. STANNARD, Chairman,
N. L. PATTERSON,
CHAS. F. NEWPORT,

January 29, 1910. Committee on Tests.

The report of the Committee to Gather Data in regard to Appliances and Methods of Operation of Atmospheric Vacuum Systems, Mr. George D. Hoffman, chairman, was read in abstract by Mr. Bolton, and on motion was referred to the Board of Governors to decide upon its publication.

The President appointed, to serve as tellers of election, Messrs. E. K. Munroe, H. W. Whitten and B. C. Davis.

The President appointed Mr. Bolton and Mr. William M. Mackay a committee to draft resolutions of sympathy in respect to the deaths that have occurred in the membership since the last meeting, and a committee, consisting of Mr. James Mackay, Mr. F. K. Davis and Mr. F. D. B. Ingalls, to audit the books of the Treasurer.

President Hoffman: The next order is new business.

Mr. Lewis: In reference to the Publicity Committee I feel that by the resolution under which it was appointed it was not ill conceived exactly, but that it is not serving a useful purpose, that it is not satisfactory to the organization, that it covers ground that other committees cover, and I move that the Publicity Committee be discharged with the thanks of the Society.

The motion was seconded and carried.

Mr. Whitten: Mr. President, under the head of new business you will note in Mr. Hale's report that a communication was received by his committee as to the situation in Massachusetts in regard to compulsory legislation, and a committee was asked for, prior to the summer meeting, to assist the central committee of that State. The reason this was asked for was because the Committee on Compulsory Legislation was appointed too late to have any new legislation introduced into the Massachusetts Legislature of last year; and not only that, but a commission has been appointed by the Legislature to report to the next Legislature recommendations on changing and simplifying laws in that State. An endeavor was made by your committee to get an engineer on that commission. An engineer was appointed, one of our members, but he was later advised it would be better for him to withdraw his name, because he sold an engine, and that would impair his work on the commission. Later an agent of a cotton mill was appointed in his place.

The time for introducing new legislation in Massachusetts has expired again this year and, as far as our Committee on Legislation knows, no special committee has been appointed. I and several members of this Society who live in Massachusetts are firmly of the opinion that some special committee should be appointed to perhaps amend legislation that may be recommended by this commission or to at least work in the general direction of a good valid law.

I move, therefore, that a special committee be appointed to

serve for two years in conjunction with the Committee on Compulsory Legislation in the State of Massachusetts.

There is opportunity for a committee to work this year, because there will be a report. A recommendation has already been made from this commission which this committee could work on effectively. Also there were two bills introduced in the Massachusetts Legislature by two members of this Society which are in such shape that some good may be done with them later on.

Mr. Myrick: As a member of the Publicity Committee I attended every meeting in Massachusetts where the discussion of ventilation came up. Two weeks ago the public were invited to the Twentieth Century Club in Boston to discuss the ventilation of street cars and also public buildings. The State deputy chief of police, who is a member of our Society, was there, and I advised him that they ought to put in some legislation, and they could afterwards change it or modify it in any way. But the time went by and there was no authority of the Society there, and I took it upon myself to introduce two bills in the Massachusetts Senate, as they could be changed later. Many States copy from what they call the Massachusetts law. As a matter of fact there is no Massachusetts law. There are simply recommendations, which are looked upon by the State Board of Health as laws. So Massachusetts has less legislation on ventilation than you might imagine.

Now it seems to me that this Society, if it has a Legislative Committee, ought to formulate some plan. We are attending here trying to get uniform laws. We must go before the Legislature with knowledge of what we want and have something sensible and intelligent to present. It must come through this Society. I believe if a new law in Massachusetts were backed by the Society, and we had somebody who would get up and discuss it intelligently, we would get some legislation over there, and I am in favor of the motion, and I second it.

Mr. Moore: Massachusetts certainly stands in need of assistance from this association. We began in 1887 first for compulsory ventilation, which resulted in a law in 1888. That went along with improvements until 1905, and then the State Board of Health began a movement by asking for appropriations and committees, and three or four young doctors were hired. They made a report in 1907 that practically took away from the

Massachusetts district police all control over heating and ventilating engineering work, and the police inspectors were deprived of all power whatever, even to enter a building. In 1908 there was an attempt made to put the control back again into the State police department. In 1909 we succeeded in getting back the ventilation as relating to all public buildings. Factories, workshops, and all mercantile establishments are now in the hands of the physicians. It has been impossible for the heating and ventilating engineers to get any definite requirements from the State Board of Health. The inspectors of the police department previously had charge of that. The plans were necessarily submitted to the department, and if any defects or anything not in accordance with law were found, attention was called to them. Many of our inspectors have had quite an extended experience, but the State Board of Health has refused to give any assistance to the heating and ventilating engineers. We are now on the downward track unless we can have some help from some one else.

The motion was carried.

Mr. Lewis: I move that the President be requested to appoint a committee of three to draft a new Publicity Committee resolution to report at the meeting to-morrow afternoon.

The motion was seconded and carried.

Mr. Barron: I want to make a motion to have a committee appointed on the subject of guarantees. You know that many manufacturers and many engineers have opinions about the subject of specifications requiring a guarantee of results. Some contend that the guarantee should only cover material and quality of workmanship. We know the practice has been in the past, and very largely in the present, for consulting engineers to require the contractor to guarantee results from his workmanship and materials. It would be well to have a committee to consider all phases of the subject; and I move that a committee of three be appointed to consider the subject of guarantees of heating, ventilation and humidity, and report at the next annual meeting.

The motion was seconded and carried.

On motion the session adjourned.

First Day—Evening Session.

(Tuesday, January 24, 1911.)

The meeting was called to order at 8.45 P. M. by President Hoffman.

President Hoffman: I will call for the reading of the first paper of the evening, and we will postpone the first part of the program until the report of the tellers is here.

The paper by Mr. B. T. Gifford, on "Pipe Line Design for Central Station Heating," was read by Mr. James Mackay. The paper was discussed by Messrs. Bishop, Donnelly, Jellett and Bushnell.

The report of the Committee on Boiler Ratings was read by Mr. Donnelly. It was discussed by Messrs. Harding, Kent, Quay, Snow, F. K. Davis, Barwick, Barron and James Mackay.

Mr. Berry: This report seems to me to be very valuable and a long step towards securing information which may be considered standard, upon which the installing engineer may base his calculations. In order that this report may take the usual course, I move that it be received and placed on file.

The motion was seconded and carried.

President Hoffman: We will pass to the next order of business, the report of the tellers.

The report was read as follows:

The undersigned committee appointed as tellers to count the ballot for officers for the ensuing year respectfully submit the following report:

There were 236 ballots cast, and two blanks, as follows:

For President.

Reginald P. Bolton 143
B. F. Stangland 91

For First Vice-President.

John R. Allen 118
S. R. Lewis 115

For Second Vice-President.

Albert B. Franklin 138
Ralph Collamore 94

For Secretary.

William M. Mackay 112
Charles E. Scott 7
W. W. Macon 115

For Treasurer.

U. G. Scollay 154
Thomas Barwick 72

For Board of Governors.

(Five is the number to be elected.)

James D. Hoffman 176
August Kehm 161
R. C. Carpenter 141
James H. Davis 127
John T. Bradley 114
J. A. Goodrich 110
Howard T. Gates 94
Henry S. Downe 92
Charles G. Armstrong 79
L. B. Sherman 50

(Signed)

E. K. Munroe,
H. W. Whitten,
Bert C. Davis,
Tellers.

President Hoffman: It becomes the duty of the Chairman to rule as out of order all ballots having names inserted, and announce the following officers for the ensuing year:

Mr. Reginald P. Bolton, President;
Mr. John R. Allen, First Vice-President;
Mr. Albert B. Franklin, Second Vice-President;
Mr. William M. Mackay, Secretary;
Mr. U. G. Scollay, Treasurer.

Messrs. James D. Hoffman, August Kehm, R. C. Carpenter, James H. Davis and John T. Bradley for the Board of Governors.

Mr. Jellett: Mr. President, I do not agree with the ruling of the Chair on this matter. I am sorry to have to disagree with

him, but the whole purport and contention of this constitution when drawn was that it should express the will of the majority of the members of this Society.

That being the case, there is no question in my mind but that the member of the Society who received the highest vote is in all justice the successful man, and I therefore would appeal from the decision of the Chair on the Secretaryship vote.

President Hoffman: Is this appeal seconded?

The appeal was seconded.

Mr. Chew: I move that the meeting rise and go into committee of the whole.

The motion was seconded.

The President: The motion as it now stands is that we rise and go into committee of the whole. Are you ready for the question? All those in favor will please stand. Mr. James H. Davis and Mr. Lewis will count the members on either side and report to the Chair.

The motion was carried.

(An intermission followed, during which the visitors retired.)

President Hoffman: The meeting will come to order. The Chair will now submit to the membership the appeal from its decision. I believe this appeal has been seconded and is ready for your consideration.

Mr. Snow: I was interested to look into this matter to satisfy myself, having made up my own mind at the outset, since I could find nothing in the constitution to prohibit the writing in of a name on the ballot other than those submitted by the Nominating Committee, that such action was permissible and that such a vote should be counted. I took occasion to investigate the practice of other societies in similar matters; and I wrote the Secretary of the Massachusetts Institute of Technology Alumni Association, a very large body with a very simple constitution, and their by-laws state that the Nominating Committee shall transmit to the Secretary nominations for the offices to be filled, and further on it constitutes the Nominating Committee that does that. Further on still it states that additional nominations may be made for any office of the association, signed by at least thirty members of the association entitled to vote and that such nominee shall be placed on the official ballot; but the Secretary writes me that there is nothing in the constitution of the Alumni

Association to prevent members from voting for whomsoever they see fit at the annual election. Provision is made on the printed ballot for filling in names other than those reported by the Nominating Committee. The constitution does not say that a choice shall be made from the printed ballot. And I draw a very close analogy between that organization, gentlemen, and ours.

I had occasion also to look into the by-laws of another very large organization, the Massachusetts Republican Club; and they have a provision there by which a name may be added to the ballot at the signed request of ten members. But that does not prevent any member inserting the name of any other person eligible to office, if they are not satisfied with the nominee presented by the Nominating Committee, or with any other nominations that may have been made by ten members. Therefore I am perfectly clear in my own mind, from having investigated this matter, that any one here has a perfect, and you might say an inalienable, right to insert the name of any candidate who is eligible to the office, and that the person or the candidate receiving the highest number of votes should be declared elected in accordance with the constitution. And I certainly hope that Mr. Jellett's protest of the ruling of the Chair will be sustained by the members here.

Mr. James Mackay: There are many organizations that have peculiar methods of nominating the officers. I belong to several organizations, but I know of none whereby a name can be used that has not been regularly nominated. I know where it was done it was considered strictly illegal. However this constitution and by-laws provides for nominating and for election. It provides for a regular ticket. Possibly another ticket should be put in the field. That should have been provided here with forethought. Why not do this as business men should, by a change in the constitution and by-laws? Now as to an independent ticket, under this constitution and the best legal light we have, the laws of the State of New York governing the organization, we have a constitution and by-laws that we are governed by, and why we should seek to dodge that is a question for one of legal attainments to determine.

Mr. Quay: In article 7, section 3, of the constitution it says: "Each member entitled to vote shall erase the names of all candidates for whom he does not wish to vote." It does not state that

he is not allowed to add a name that has not been put on by the Nominating Committee. The constitution of the United States and the State laws provide that a member of any organization has a right to express his views and to vote for the man that he thinks is best suited to the office. And, as has been stated, the mention of certain names by the Nominating Committee does not prohibit a member from voting for any other man that he wishes to. What is not prohibited in the law is permissive. Our constitution does not state that a man shall not add a name, after erasing the names of all candidates, and vote for that nominee.

Mr. Jellett: The only ruling that was made, as I understand it, was on the question of the secretaryship. That is the ruling that I objected to, not the general ruling on the entire ballot. And yet if the ballot on the secretaryship is incorrect, as the President has urged, then all the votes on those particular ballots are void. If the Society votes to sustain the Chairman on that ruling, then all those ballots must be thrown out. Each is a complete ballot, and you cannot pick out a section of it and rule that a part is irregular and that the rest of the ballot is correct.

Mr. Davis: In all elections the ballot that is affected is thrown out, not part of it counted and the rest thrown out, but all thrown out.

President Hoffman: I believe your suggestion is a correct one.

The question was further debated by Messrs. Kent, Bishop, Donnelly, J. H. Davis, Munroe, Berry, Snow, Mehring, Jellett and Scollay.

President Hoffman: The question stands, shall the decision of the Chair be the decision of the meeting? All of those who support the decision of the Chair will please rise and the same tellers will count and report. Remain standing while the count is going on.

The tellers reported ten votes in favor.

President Hoffman: All those who are opposed to the decision of the Chair being the decision of the Society please rise. There is no need of a count. You may be seated. The decision of the Chair has been reversed.

Now the Chair awaits instructions from the meeting.

Mr. Barron: I move, Mr. President, that Mr. Macon be declared the elected candidate of the Society.

The motion was seconded.

President Hoffman: The motion that Mr. Macon be declared elected by the meeting has been seconded. Are there any remarks?

Mr. Myrick: I move that the votes as counted by the tellers be accepted as official for the Society.

President Hoffman: Is this to replace the other motion or an amendment?

Mr. Barron: I accept that as a substitute, Mr. President.

President Hoffman: Does the second accept?

A Member: I accept that.

President Hoffman: The motion then stands that the Chair declare the candidates elected according to the report of the tellers.

The motion was put to a vote and carried.

Mr. Jellett: I think it is in order now for the president to make an official statement as to who is elected to the various offices.

President Hoffman: According to the last motion and the fact that it was carried, the Chair will declare the following persons elected to the respective positions:

Reginald P. Bolton, President;

John R. Allen, First Vice-President;

Albert B. Franklin, Second Vice-President;

W. W. Macon, Secretary;

U. G. Scollay, Treasurer;

And the following names in order for the Board of Governors:

James D. Hoffman, August Kehm, R. C. Carpenter, James H. Davis, John T. Bradley.

On motion the meeting adjourned until Wednesday afternoon.

Second Day—Afternoon Session.

(Wednesday, January 25, 1911.)

The meeting was called to order at 12.30 P. M. by President Hoffman.

Mr. F. N. Speller read a paper on "The Durability of Wrought Iron and Steel Pipe in Service."

The paper was discussed by Messrs. Barwick, Carpenter, Barron, James H. Davis, F. K. Davis, Waldron, Kent, Boyden, and Franklin.

The report of the Committee on Interpretation of the Constitution was read by Mr. Kent.

REPORT OF COMMITTEE ON INTERPRETATION OF THE CONSTITUTION.

At the annual meeting of this Society held in January, 1910, this resolution was passed.

Resolved, That a committee be appointed to investigate the purpose of the constitution on certain points which may not seem to be clear and report its interpretation on these points.

The committee appointed by President Hoffman submits the following report.

At the annual meeting interpretation was desired as to these three points:

(1) The term of office of the Board of Governors.

(2) Is the Society when in session supreme?

(3) Art. VI, Sec. 1, relating to meetings of the Board of Governors.

It was also requested that the committee recommend some method of safeguarding the members in relation to papers presented as well as safeguarding the Society.

Taking up first the question of the term of office of the Board of Governors, an extract from Art. VII, Sec. 4, states: "The candidates receiving the highest vote for the several offices shall be declared elected, and shall take office at the last session of the annual meeting."

We hold that the term of office of the Board of Governors continues from the time they take office until their duly elected successors take office.

To answer the second question: "Is the Society when in session supreme?" requires a careful consideration of our constitution and by-laws and the usage in the relation between corporations or associations and their boards of directors.

Art. III of our Charter states: "The number of directors and managers of said Society shall be seven."

These directors and managers are termed the Board of Governors.

Art. VI, Sec. 5, states: "The Board of Governors . . . shall have the supervision and care of all the property of the Society,

and shall manage and conduct its affairs in accordance with the Charter and By-Laws."

The duties of the Board of Governors are set forth in: Art. II, Sec. 1; Art. III, Sec. 2, Sec. 4 and Sec. 5; Art. IV, Sec. 2, Sec. 4, Sec. 7 and Sec. 8; Art. VI, Sec. 1, Sec. 3, Sec. 4 and Sec. 5; Art. VII, Sec. 1 and Sec. 5; Art. VIII, Sec. 1, Sec. 2 and Sec. 4; Art. IX, Art. XI and Art. XII.

In the references given the reader will find that the work of the Board of Governors in the interest of the Society as a whole is pretty fully covered.

Under the constitution the Society elects this Board of Governors to manage and conduct its affairs in accordance with the Charter and By-Laws.

Your committee is of the opinion that the Board of Governors acts for the whole Society which elects the Board, and that it is not subject to the instructions of a portion of the entire membership which may be present at a regular meeting of the Society, or indeed, to instructions of the entire membership.

Should the Society at a regular meeting vote to instruct the Board of Governors to do certain things your committee is of the opinion that such instructions should be considered merely as recommendations to the Board.

The Society, having placed the management and conduct of its affairs in the hands of its Board of Governors, thereby relinquishes its right to instruct this Board.

As to the third question (3) relating to special meetings of the Board of Governors, according to Art. VI, Sec. 1, these may be called by the President on his own volition or when so requested by three members of the Board of Governors or when so requested in writing by ten members of the Society.

The constitution, in the minds of your committee, appears to be perfectly clear as to how special meetings of the Board of Governors may be called and requires no interpretation.

The member requesting the interpretation of this clause stated that so far as he knew the members of the Society calling a special meeting of the Board of Governors have no right to be present.

Your committee believes that this Section was included in the constitution to provide for the handling of matters that should receive attention in the interim between regular meetings of the

Board of Governors, and believes that the Board of Governors in managing and conducting the affairs of the Society in accordance with Art. VI, Sec. 5, would naturally request the presence of the members requesting a special meeting at the meeting so called.

As to the request made at the last annual meeting that the committee recommend some method of safeguarding the members in relation to papers presented as well as safeguarding the Society, your committee would report that Sec. VI, Art. 5, states:

"The Publication Committee shall receive and examine all papers for presentation to the Society, and accept for publication such as it may approve."

The Publication Committee as well as other Standing Committees appointed by the President "shall be guided by such rules and regulations as the Board of Governors shall from time to time prescribe."

Your committee believes that, owing to the late date at which papers for presentation at meetings are often received, it is impossible for the Publication Committee before the date of the meeting to give the time and care necessary to protect as fully as they would wish the interests of the Society.

As to safeguarding members in relation to papers offered, the obvious thing to recommend appears to be to require that, in accordance with the rule of the Board of Governors, papers to be presented at meetings shall be in the hands of the Secretary at least thirty days prior to the date of the meeting, and that papers for presentation shall conform to such rules as may be prescribed by the Publication Committee.

This report has been submitted to legal counsel employed by the Committee, and he concurs in our views.

(Signed) December 8th, 1910.

$\left.\begin{array}{l}\text{Wm. G. Snow,}\\ \text{Wm. M. Mackay,}\\ \text{Wm. Kent,}\\ \text{A. E. Kenrick,}\\ \text{C. B. J. Snyder,}\\ \text{Frank K. Chew,}\end{array}\right\}$ *Members of Committee.*

On motion the report was received. It was discussed by Messrs. Jellett, Barron, Chew, Kent and Snow. Mr. Jellett especially objected to the clause of the report which reads, "that

the Board of Governors acts for the whole Society, which elects the Board, and that it is not subject to the instructions of a portion of the entire membership which may be present at a regular meeting of the Society."

Mr. Chew moved that the report be referred to a committee to be appointed to revise the constitution and by-laws. Mr. Kent moved to substitute for Mr. Chew's motion a motion that a committee of five members, of whom Mr. Jellett and Mr. Chew are to be two members, be appointed to submit proposed amendments to the constitution and by-laws, and that the report just received be referred to that committee.

Mr. Chew accepted the substitute, which was seconded and carried.

(The Board of Governors later appointed as this committee Messrs. Kent, Jellett, Chew, Snow and R. C. Carpenter.)

President Hoffman: The next order on our program is a topic for discussion which was held over from yesterday: "Objection to the Making of Plans by Manufacturers for the Installation of Their Apparatus." If the party who proposed the topic is not here we will pass on to the regular order of the afternoon. The Secretary will read the paper entitled "The Value of Good Ventilation," by Prof. Severance Burrage, Lafayette, Indiana, non-member of the Society.

The paper was read by Secretary Mackay.

President Hoffman: We have another paper here on the same subject by Dr. Evans, of Chicago, and the Chair has asked Prof. Kent to read this paper.

The paper was read by Prof. Kent.

President Hoffman: The two papers now are before you for discussion.

The papers were discussed by Messrs. Kent, Lewis, Bolton, Gulick, Barron and Myrick.

President Hoffman: The question is that a committee be appointed by the incoming President to confer with a similar committee from the American Society of School Hygiene upon standards of ventilation.

The motion was put to a vote and carried.

Mr. Lewis: I move that the thanks of the Society be extended to Dr. Burrage and Dr. Evans for the papers which they have presented. (Carried by a rising vote.)

President Hoffman: Is there any further report or business for the evening?

Mr. F. K. Davis: I would move that a committee be appointed by this Society to gather data and report to the Society a recommendation for a standard or qualification of a heating and ventilating engineer, with the aim and object to get some statute or law to protect the public as well as the engineer.

Mr. Barron. We may consider this as perhaps desirable, but it is down in our constitution, the qualifications of a heating and ventilating engineer. You will find it required that every applicant must have such and such qualifications. Now if we are going to adopt another standard it would be well that we should consider when we are voting for it that already our constitution defines what a heating and ventilating engineer is, as a member of this Society.

Mr. Barwick: The object of Mr. Davis' motion is to define what an engineer is, whether he is a member of this organization or not. A great many men that put in plants as heating and ventilating engineers are not qualified to put them in. I think it is about time we had a standard of some kind in this country.

President Hoffman: If there are no further remarks all in favor of the question signify it by saying aye. All opposed no. I will call for a rising vote. All in favor of the motion please stand. The motion is lost.

On motion the meeting adjourned until Thursday morning.

Third Day—Morning Session.

(Thursday, January 26, 1911.)

The meeting was called to order at 10.55 A. M. by President Hoffman.

The report of the Committee on Standards was read by Prof. Carpenter.

On motion of Mr. Chew the report was received and placed on file.

REPORT OF COMMITTEE ON STANDARDS.

Gentlemen: Your Committee on Standards have very little to report. The question referred to this committee at the last annual meeting, relating to a standard rating for heating boilers,

should in the opinion of your committee be first considered and reported on by the Special Committee on Boiler Rating.

Your Committee on Standards would suggest that in view of the scientific information recently given to the Society, as to the physiological effects on the human body of air currents, that a standard of ventilation should require both volume and circulation.

At the St. Louis meeting certain questions were referred to the Committee on Standards. These questions were given consideration, but the committee is not as yet ready to report to the Society on them. It is not the purpose of this committee to propose standards or to obtain the necessary data to establish standards.

The committee would, however, suggest that necessary investigations be made on a standard method, both accurate and approximate, for testing heating boilers, and that a special committee be appointed for this purpose.

Respectfully submitted,

R. C. Carpenter,
J. J. Blackmore,
Howard T. Gates,
August Kehm,
W. W. Macon,

Committee.

Mr. Chew: Prof. Carpenter has suggested that there should be a special committee to codify the methods of testing boilers, if I understand the suggestion, and beyond doubt it would be a proper thing to do; but it seems to me, after the number of years we have had a Committee of Standards, they ought to be able, instead of presenting a report suggesting that a committee be appointed, to suggest what ought to be done; and that really there ought to be some constructive work done by these standard committees. I believe Prof. Carpenter and his colleagues can formulate something constructive in that line before the next annual meeting. The Professor and I had a talk this morning, and I believe that we are on the eve of a progressive movement. I feel that some work ought to be done along progressive lines.

President Hoffman: The next in order is the reading of a paper, "Ventilation of the Capitol, Washington, D. C.," by Nelson S. Thompson, member of the Society.

The paper was read by Mr. Bradbury and discussed by Messrs. Carpenter, Whitten, J. H. Davis, Moore, Lewis, Franklin, Macon, Hoffman, F. K. Davis, Mobley, Fitts and Ingalls.

Mr. Lewis: I have the resolution for the Publicity Committee ready, and I move its adoption:

> Resolved, That a Publicity Committee of three members from one locality be appointed by the incoming President, this committee to secure publicity for the work and aims of the Society, and to promote the dissemination of literature concerning heating and ventilating and subjects relating thereto, the work of this committee to be subject to the advice and control of the Board of Governors.

The motion was seconded, put to a vote and carried.

Mr. Hale: You will recall that in my report as chairman of the Committee on Compulsory Legislation I mentioned a communication received from one of our Ohio members, relative to the new code now being prepared for that State. We are informed that Mr. Fred W. Elliott, of Columbus, Ohio, has been appointed to make an investigation as to the best paragraphs to embody in the code relative to the ventilation of buildings. It has been suggested that we extend to Mr. Elliott an invitation to visit New York and co-operate with a committee to be appointed by the Chair, and I wish to make a motion that we extend this invitation to Mr. Elliott and request the Chair to appoint a committee of three to meet the gentleman when he visits this city.

The motion was seconded and carried.

Mr. Bradbury: I would like to call attention to this one item in the paper of Mr. Thompson: "I am of the opinion that the Society should convey its thanks to Dr. Roberts for permitting his report to be presented, as I deem it a valuable document and one which will interest the members." I make a motion that this Society tender a vote of thanks.

The motion was put and carried.

The session then adjourned.

Third Day—Afternoon Session.

(Thursday, January 26, 1911.)

The meeting was called to order at 2.00 P. M. by President Hoffman.

President Hoffman: We will first take up some of the committee reports that were left over.

Secretary Mackay: One of the reports, Mr. President, is the report of the Auditing Committee, James Mackay, chairman.

Mr. James Mackay: While we have no written report, we went over the books very carefully, every entry, every disbursement, every check, every bill, checked them back through the year, balanced the Secretary's book against the Treasurer's book, footed up every column and checked every entry, and we find everything correct and so certify the books, signing each name of the committee.

President Hoffman: Our record should state that it was signed by the full committee. The committee was composed of Mr. James Mackay, Mr. F. K. Davis and Mr. F. D. Ingalls.

Mr. James Mackay: The full committee signed both books.

President Hoffman: We will now take up the "Report of Committee on the Effect of Air Leakage and Wind Velocities on Heating Guarantees," Mr. D. M. Quay, chairman.

The report was read by Mr. Whitten.

On motion the report was accepted and placed on file. It was discussed by Messrs. Whitten, Carpenter, Barron, Cooper and Barwick.

President Hoffman: We will take up next the report of the Committee on Legislation for New York State, Mr. D. D. Kimball, chairman.

The report was read by Secretary Mackay.

Report of the Committee on Legislation in New York State.

(With discussions of a proposed act, and of the status of the laws of Massachusetts regarding ventilation.)

Gentlemen: In reporting for the Special Committee on Legislation for New York State, the report must still be one of progress. During the summer and fall months much time was spent by the

committee in securing data and investigating conditions involved in the subject of factory loft ventilation. Later several conferences were held with the Commissioner of Labor, the real estate people and representatives of the American Association for the Advancement of Labor Legislation, which has become interested in the subject of factory loft ventilation.

On the evening of December 14th a general conference was held at the rooms of the above association, at which were present representatives of that association, this committee, the real estate people, and also Mr. John Williams, Commissioner of Labor, and Mr. P. T. Sherman, former Commissioner of Labor. The matter was thoroughly discussed, and a Sub-Committee was appointed consisting of Mr. Sherman, Mr. Williams, Mr. Bastine (representing the real estate people) and the chairman of this committee. This committee met later and further discussed the subject, the different members of the committee making suggestions and drafts for the various portions of the bill. This matter was placed in the hands of Commissioner Williams to draft into a bill. This he did carefully and well, and a copy was sent to each member of the sub-committee. The matter was again carefully considered by the special committee on the part of this Society, and two suggestions were made which were accepted by the sub-committee above referred to. The proposed bill has been placed before an attorney for an opinion as to its present form, and we await his report. A copy of this bill is attached hereto.

We are free to confess that the bill is not exactly in the form which we might desire, but we have met with the most strenuous opposition to some of the proposals advanced by our committee originally. We would especially prefer to see the reference to the CO_2 standard eliminated, as tending to make the bill simpler and more successful in administration. However, we feel that this bill, if properly administered, will assure proper factory ventilation.

It is proposed that the bill shall be introduced to the Legislature by the American Association for the Advancement of Labor Legislation, which will give the bill the advantage of coming from a source free from prejudice or self interest.

A large group of associations interested in the welfare of the working people has been interested in the subject, and these as-

sociations have agreed to use their influence and efforts to bring about its passage. The real estate people only are now in a position of opposition, and their position apparently is more that of desiring to see a bill which may be honestly enforced and without injury to their property interests. It is believed that we will be able to come to a satisfactory agreement with them, so that the bill may enter the legislature without opposition so far as is known.

Suggestions and comment on the part of members of the Society, or instructions from the Society regarding this bill will be appreciated.

Respectfully submitted,

D. D. Kimball, Chairman.

Appendix.

AN ACT.

To amend the labor law, in relation to ventilation in factories.

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

Section 1. Section eighty-six of chapter thirty-six of the laws of nineteen hundred and nine entitled "An act relating to labor, constituting chapter thirty-one of the consolidated laws," is hereby amended to read as follows:

86. Ventilation and temperature. The owner, agent or lessee of a factory shall provide, in each workroom thereof, proper and sufficient means of ventilation, and shall maintain proper and sufficient ventilation; if excessive heat be created or if steam gases, vapors, dust or other impurities that may be injurious to health be generated in the course of the manufacturing process carried on therein the room must be ventilated in such a manner as to render them harmless, so far as is practicable; in case of failure the Commissioner of Labor shall order such ventilation to be provided. Such owner, agent or lessee shall provide such ventilation within twenty days after the service upon him of such order, and in case of failure, shall forfeit to the people of the State, ten dollars for each day after the expiration of such twenty days, to be recovered by the Commissioner of Labor.

Each and every workroom of a factory shall be provided with proper and sufficient means of ventilation and shall be kept properly and sufficiently ventilated; and such ventilation shall be provided without causing injurious drafts and without lowering the

temperature in the working parts of the room unduly or in any event below sixty degrees Fahrenheit. A workroom shall be deemed insufficiently ventilated if the air in any of the working parts thereof is found to contain more than nine parts of carbon dioxide in ten thousand volumes of air in excess of the proportion in the exterior air. Provided, however, that a workroom shall be deemed to be provided with sufficient means of ventilation, if provided with means of ventilation which will supply constantly throughout the interior of the room at least twelve hundred cubic feet of air per hour for each and every person therein present or employed, and in addition at least one thousand cubic feet of air per hour for each and every cubic foot of gas burned per hour, such air to be taken from an uncontaminated source; and such room shall be deemed to be sufficiently ventilated if such means of ventilation are constantly and properly used. Provided further, however, that if excessive heat is created, or if gases, fumes, vapors, fibre, dust or other impurities are generated or released in the course of the manufacturing process carried on therein the room must be further ventilated in such a manner as to reduce such excessive heat and to remove such gases, fumes, vapors, fibres, dust or other impurities. A temperature in any workroom, except a boiler room, in excess of ninety degrees Fahrenheit shall be deemed excessive heat, unless the temperature of the exterior air also exceeds that degree.

It shall be the duty of the Commissioner of Labor to apply and enforce the foregoing tests of the air in any workroom at the time of maximum occupation and when the unobstructed wind velocity in the vicinity of such workroom does not exceed eight miles an hour.

It shall be the duty of the owner or lessee of a building used in whole or in part for factory purposes, and of the agent of either such owner or lessee, to provide in each factory workroom in such building proper and sufficient means of ventilation, provided, that when the occupier or anyone through whom his right of possession is derived has agreed in writing to comply with the provisions of this section or an order issued thereunder, within his holding, and the owner, lessee or agent before or within twenty days after notice to him to provide such means of ventilation, has furnished to the Commissioner of Labor a true and full copy of the lease or writing containing such agreement, the occupier instead of the owner or lessee, or their agents, shall be responsible for the performance of the duty herein prescribed.

It shall be the duty of the occupier, within his holding, to maintain proper and sufficient ventilation in each workroom; and if in the course of the manufacturing process carried on therein excessive heat is created or gases, fumes, vapors, dust, fibre, or

impurities are generated or released, to provide and use in addition such other and further means of ventilation as may be necessary to reduce such excessive heat and to remove such gases, fumes, vapors, dust, fibre or impurities, and when proper and sufficient means of ventilation have been provided in a workroom, it shall be the duty of the occupier constantly to use such means so as to keep the workroom properly and sufficiently ventilated.

The term "occupier" as used in this section shall mean the tenant or lessee in actual possession of any part of a building which part is so used as to constitute in law a factory.

If the Commissioner of Labor finds that a factory workroom is not provided with proper and sufficient means of ventilation he shall issue or cause to be issued to the owner or lessee of the building wherein such workroom is located, or to the agent of either such owner or lessee, or to the occupier, if he is responsible as hereinbefore provided, an order requiring such person to provide means to properly and sufficiently ventilate such workroom within thirty days from the date of such order. Such order shall be deemed to be served when it has been deposited in the post in a prepaid wrapper directed to such person to be served, at his residence or customary place of business. If the Commissioner of Labor finds that in the course of the manufacturing process carried on in a factory workroom excessive heat is created, or gases, fumes, vapors, dust, fibre or impurities are generated or released, he shall issue or cause to be issued to the occupier, an order requiring him to provide such additional means as may be necessary to properly and sufficiently ventilate such workroom, or to reduce such excessive heat or to remove such gases, fumes, vapors, dust, fibre or impurities within thirty days from the service of such order; and such order shall be served as hereinbefore prescribed.

The Commissioner of Labor shall include in the staff of the bureau of factory inspection an experienced heating and ventilating engineer whose duty it shall be under the direction of the Commissioner of Labor to examine and approve or disapprove plans for ventilating factory workrooms and to decide engineering questions arising in connection with the administration of this section; such decisions shall be subject to appeal to the Commissioner of Labor.

Any person having a duty to perform under the provisions of this section who fails to provide proper and sufficient means of ventilation in a factory workroom within thirty days after the service of the order hereinbefore prescribed, shall forfeit to the people of the State ten dollars for each day after the expiration of such thirty days, to be recovered by the Commissioner of Labor. Any occupier who fails to constantly maintain proper

and sufficient ventilation in any factory workroom shall be guilty of a misdemeanor.

2. This act shall take effect immediately.

DISCUSSION.

Mr. Whitten: I would like to ask the significance of that statement that this test shall be taken when the wind is not more than eight miles an hour.

Prof. Carpenter: You understand this bill is not what any one of us would like here as the law, but it seems about the best we can get. There are difficulties about an inspection of any kind, and inspectors may take advantage for their personal benefit. It seems to me if we can get this bill passed in some shape, that later we can easily get it amended; I believe that the general interest which is now felt on the subject of proper ventilation and proper health of workingmen will lead to the perfection of the law in a few years. This bill as it stands is not what the committee would like to have, but what it is hoped that we can get.

Mr. Whitten: I wonder what is the reason why the wind velocity enters into it at all.

Prof. Carpenter: Let me tell you why it enters into the requirements of the bill. We have two standards in this bill, the volumetric standard and the chemical or CO_2 standard. A strong wind blowing against a room will affect the composition of the air and give a result different from that expected if we had no wind at all. We cannot restrict our examinations to a time when there shall be no wind, but we can require that the test shall not be made when the wind is blowing very hard, say above eight miles an hour. Under such conditions we believe that that CO_2 test would fail and would not show fair results.

Mr. Whitten: I think you would find from a series of tests that I have made in that regard that you would get pretty nearly a fair average of an average building in this town, a loft building, where the wind blew straight through it. If the rooms are divided or they were on the exposed or sheltered side, I find that the rooms on the leeward side usually contain a larger quantity of CO_2 than those on the exposed side. When there was comparatively no wind the amount of CO_2 would then be fairly definitely distributed through the building; but the total amount of CO_2 under those circumstances that I have mentioned has in

almost every case been more in the rooms on the leeward and less on the windward, or evenly diffused if there was no wind.

Mr. Chew: That bill represents a lot of work done by Mr. Kimball and Prof. Carpenter. The Commissioner of Labor was without any standards at all for forced factory ventilation, and he came to this Society or other societies for help, because he said that he wanted 2,000 feet of air per person. Then he ignored us, and we had to go to the Legislature and tell them we had a right to come because we had been there ten years and had acted for the whole of New York State in securing compulsory legislation laws for the schools. We talked with the joint committee of the Senate and House, who admitted that they were there in the interests of the people and realized that the property of New York State woull not be of any value except for the people who made it valuable. They were told that we didn't care anything about what it might cost to make a building inhabitable, we insisted that the citizens should have proper treatment. When we asked questions about the temperature of boiler rooms, we found this had nothing to do with our committee, we only had to do with the positive injection of air into a room occupied as a factory. This bill is a compromise measure, but fortunately we have some things in it that we want. We haven't the whole thing, but there is a place in the bill saying that there shall be an engineer employed by the Commissioner of Labor who is competent to pass on these things, and that a property owner, who is dissatisfied with what the engineer has done, can appeal to the Commissioner of Labor, and there are penalties if the law is not observed.

Mr. Myrick: I was not trying to criticise the bill. I was only trying to apply it. Fortunately now the head of the Massachusetts District Police is with us. We have had a lot of agitation by various reformers who succeeded in getting a bill through the Massachusetts Legislature last year. Their committee had no engineer on it, only included a lawyer, a doctor, a labor agitator, two ladies and a mill-owner. We have a State Board of Health that runs everything. I think you should get a bill like that of Massachusetts, which does not mean anything as a fixed standard, but is simply a recommendation.

If you lay down a standard you give people a chance to attack the standard; but with a recommendation a commission may be

appointed. We have been trying to put the matter in the hands of the police, and take it away from the doctors, who have got a certain amount of our jurisdiction.

If we should show we are not antagonistic, that we are simply educational, and want to co-operate in the passage of some bill something may be accomplished in the near future.

Mr. Chew: We already have that law and the Commissioner of Labor has that authority, but he has had trouble, and that is the reason he looks to the Society for help. The people say he did not administer the law fairly. He says, "Gentlemen, leave this to me." And in endeavoring to help him, this is the best that we can get from the different interests.

The Labor Commissioner may say, "You have got to do so and so." He has recommended one thing at one time, and with better judgment has recommended another one later, which is progressive, but unfortunately inconsistent, and the factory owner complains, saying, "You make me do one thing one time and another thing another time," and he has come to us for help. We hope this law may go through. It is as much as we can get at the present time. We don't like it, but what you mentioned I think we have.

Mr. Barwick: It seems to me, after a number of years, we have got about all we can get. In a number of the loft buildings with a great number of windows, fair results are obtained with leakage through the windows, and it looks like a hardship to try to force 2,000 cubic feet of air per occupant of the building. You cannot find any building in which you can compute what the occupancy is going to be. If you provide 2,000 cubic feet of air for each of one hundred occupants of the building, and it is occupied by only fifty, the owner is wasting money. If you provide for only fifty occupants in that floor and then more than fifty occupy it, you are below the standard set by the Society or by the State Government. This new measure has given us a standard which is very low, which we can conform to, and which is a fair allowance under the present conditions. In a very short time we can educate the people to a greater amount.

Mr. Chew: In our talk before this Senate committee, Senator Grady asked me, "What is this CO_2?"

"When you speak of CO_2 it is a mystery. If you want to make a test you come inside of this room and take the air out,

and then by careful chemical treatment of it find out what the chemical proportions of it are." That was something of our discussion there.

We would be glad to have some information from Mr. Joseph A. Moore, Deputy Chief of the Inspection Department of the District Police of Massachusetts.

Mr. Moore: In Massachusetts we were very glad to get what we could at first. The first laws were in rather a crude shape and we kept working for more points. Finally we got a law that worked well until the medical inspectors of the State Board of Health stepped in and for two years deprived us of all authority. Our law now is different from what is generally understood. We have nothing to do at the present time with factories and work-shops. We did have until the authority was taken away from us in 1907, but in 1909 we got back part of our jurisdiction in connection with public buildings. The law covering this reads:

"Every public building and every school house shall be kept clean and free from effluvia arising from any drain, privy or nuisance, shall be provided with a sufficient number of proper water closets, earth closets or privies, and shall be ventilated in such a manner that the air shall not become so impure as to be injurious to health. If it appears to an inspector of factories and public buildings that further or different sanitary, ventilating or heating provisions are required in any public building or schoolhouse, in order to conform to the requirements of this section, and that such requirements can be provided without unreasonable expense, he may issue a written order to the proper person or authority, directing such sanitary, ventilating or heating provision to be provided.

"A school committee, public officer or person who has charge of, owns or leases any such public building or school house, who neglects for four weeks to comply with the order of such inspector, shall be punished by a fine of not more than $100.

"Whoever is aggrieved by the order of an inspector, issued as herein provided and relating to a public building or school house, may appeal to a judge of the superior court, as provided in Chapter 487 of the Acts of the year 1908."

I will say that the law is that the judge may either hear the case or he may appoint three disinterested persons skilled in the subject matter of the controversy. It allows the calling in of engineers or people that are competent to pass on it. Inspection

on the part of the State Board of Health is made under the following authority:

"The State inspectors of health, or such other officers as the State Board of Health may from time to time appoint, shall make such examinations of school buildings as in the opinion of said board the inspection of the health of the pupils may require. The provisions of this action shall be enforced by the State inspectors of factories and public buildings."

There was another law enacted in 1909, which gave us more authority. It is contained in Chapter 354, Acts of 1909, and reads:

"The chief of the district police, the deputy chief of the Inspection Department of the district police, and the inspectors of factories and public buildings may, in the performance of their duty in enforcing the laws of the Commonwealth, enter any building, structure or enclosure, or any part thereof, and examine the method of prevention of fire, means of exit and means of protection against accident, and may make investigations as to the employment of children, young persons and women, except concerning health and the influence of occupation upon health. They may, except in the city of Boston, enter any public building, public or private institution, school house, church, theatre, public hall, place of assemblage, or place of public resort, and make such investigations and order such structural or other changes, in said building, as are necessary, relative to the construction, occupation, heating, ventilating and the sanitary condition and appliances of the same.

"Any person who hinders or prevents or attempts to prevent any member of the Inspection Department of the District Police from entering any building, structure or enclosure or part thereof specified in the preceding section shall be liable to a penalty of not less than $50 nor more than $100."

Our department years ago established a standard. It is not law in Massachusetts, but it has been practically accepted. It is practically that there shall be at least 30 cu. ft. of fresh air supplied per minute for each occupant of a school room, and at least that amount of vitiated air removed through the vent ducts, the temperature not to vary more than 3° F. at any occupied part of the room. We generally place our thermometers upon the corner desks and at the teacher's desk, making five thermometers. No uncomfortable draft is to be perceptible and no unsanitary odors shall be noticed in the building and the building must be

heated to 70° F. in any weather. Those requirements have been in force for years and are generally observed under that provision of the law conferring on the district police the authority for enforcing the law.

Mr. Jas. H. Davis: I would like to ask if that Massachusetts law applies to parochial and private schools?

Mr. Moore: Our law applies to schools seating 10 or more persons at one time. A section of our law reads:

"No building which is designed to be used, in whole or in part, as a public building, public or private institution, school house, church, theatre, public hall, place of assemblage or place of public resort, and no building more than two stories in height, which is designed to be used above the second story, in whole or in part, as a factory, workshop or mercantile or other establishment and has accommodations for ten or more employees above said story and no building more than two stories in height designed to be used above the second story in whole or in part as a hotel, family hotel, apartment house, boarding house, lodging house, or tenement house, and has 10 or more rooms above said story, shall be erected until a copy of the plans thereof has been deposited with the inspector of factories and public buildings for the district in which it is to be erected by the person causing its erection, or by the architect thereof. Such plans shall include the method of ventilation provided therefor, and a copy of such portion of the specifications therefor as the inspector may require. Such building shall not be so erected without sufficient egresses and other means of escape from fire, properly located and constructed.

"The certificate of the inspector, endorsed with the approval of the chief of the district police, shall be conclusive evidence of a compliance with the provisions of this chapter unless, after it is granted, a change is made in the plans or specifications of such egresses and means of escape without a new certificate therefor. Such inspector may require that proper fire stops shall be provided in the floors, walls and partitions of such buildings, and may make such further requirements as may be necessary or proper to prevent the spread of fire therein or its communication from any steam boiler or heating apparatus.

"Sec. 23. No wooden flue or air duct for heating or ventilating purposes shall be placed in any building which is subject to the provisions of Sections 24 and 25 (the sections refer to buildings such as those already described, coming under the inspection of the fire inspectors), and no pipe for conveying hot air or steam in such building shall be placed or remain within 1 inch of any woodwork, unless protected to the satisfaction of said

inspector, by suitable guards or casings of incombustible material.

"Sec. 24. Whoever erects or constructs a building, or architect or other person who draws plans or specifications, or superintends the erection of a building, in violation of the provisions of this chapter, shall be punished by a fine of not less than $50 or more than $1,000."

I would say that we did not succeed in obtaining all those laws at once. We got what we could at first and then started in and added to it as fast as we were able.

President Hoffman: We have last on our program four topics for discussion, which we will take up at this time. The first one is: "Objection to the Making of Plans by Manufacturers for the Installation of Their Apparatus."

The topic was briefly discussed by Messrs. Barwick, Whitten and Barron.

The next topic, "The Desirability of having 'Ventilating Laws Apply to Private as Well as Public Schools,'" was discussed very briefly.

President Hoffman: We will pass on to question 3, topic for discussion, "The Use of Vacuum Systems in Heating Buildings." Is the gentleman here who proposed the question? If there is no discussion we will pass on to No. 4, "Smokeless Combustion in Steam Heating Plants."

Mr. Barwick: That topic is a pretty hard proposition to talk upon. I do not think that we are at the present time capable of taking it up. A smokeless furnace is a pretty hard thing to find.

President Hoffman: Any more remarks upon the smokeless furnace? Are there any papers that have not been presented or any subjects that you wish to call before the Society?

Mr. F. K. Davis: I have a resolution I would like to offer if I may be permitted at this time. I will read it:

"Whereas, our honored member, Mr. William M. Mackay, has for the past twelve years been the Secretary of this Society,

"And Whereas, he has discharged his duties with marked fidelity and devotion and to the credit of the Society;

"And Whereas, at this time he is retiring from this office;

"Be it Resolved, that the gratitude and thanks of this Society be extended Mr. William M. Mackay for his earnest and unflagging interest in the work of the Society;

"And be it further Resolved, that a rising vote of thanks be tendered him; and be it further resolved that these resolutions be

engrossed and tendered Mr. William M. Mackay in further testimonial of our appreciation and regard."

The resolution was seconded and unanimously carried by a rising vote.

Mr. Barron: There were a number of applicants for membership rejected in the last letter ballot for members. I think that something ought to be done in the matter, as there seemed to be valuable material among the number.

The subject was discussed at length by Messrs. Barron, W. M. Mackay, Chew, James Mackay, Quay, Addams, Carpenter, Whitten, Snow.

On motion of Mr. Barron, it was resolved to refer the rejected names to a committee to be appointed by the new President, said committee to report to the new Board of Governors.

On motion of Mr. Whitten, the clauses in the constitution that state the number of votes against a candidate for membership required to reject him were referred to the committee on Revision of the Constitution for special consideration.

Prof. Carpenter: Mr. Andrew Harvey, past President of the Society, has attended I think nearly every meeting since he has been a member. He is now sick and unable to be with us. I would like to offer a resolution authorizing our Secretary, Mr. Mackay, to send him a telegram expressing the regret of the members present that he was unable to attend.

The motion was seconded and carried.

Mr. Quay: In discussing the question of air leakage, the proposition to heat buildings by direct radiation, placing the radiators on the inside walls, with the rooms bottled up with no air leakage, is a very different proposition from a building heated and ventilated by mechanical ventilation. This is comparatively new to ventilating engineers, and I think that there should be a committee appointed to consider thoroughly this whole question and bring in a report at the next annual meeting as to not only the best location of radiators, but also the question of ventilation in the building with air-tight closed windows, and heated by direct radiation. Buildings that are heated by direct radiation surely need some ventilation. And I make a motion that, if we already have a committee, this matter be referred to it, but if not that a committee be appointed to make a report at the next annual meeting on this subject.

Mr. Barron: There has been a great deal of discussion here on direct radiation, in a paper that was read on ventilation. I suggest to Mr. Quay that all that matter that is solely confined to direct radiation should be separated by the editor in the proceedings, so that it will not be part and parcel of a paper on ventilation.

Mr. Myrick: I know one case here where a mechanical system of heating was installed and the question came up as to window leakage, and that was considered a very dangerous thing. So it was remedied by fixing the window so that it was airtight, double windows or something of that sort; and the ventilating engineer came around a short time afterwards and found a solid window, absolutely no leak, and he proceeded to cut a hole in that window and put a window ventilator in to let some air in, right alongside of the one that had been stopped up.

President Hoffman: The motion is to appoint a committee to investigate methods of ventilation in rooms heated by direct radiation. Is that the motion, Mr. Quay?

Mr. Quay: Either that or to refer it to one of the present committees.

The motion was put to a vote and carried.

Secretary Mackay: I move that all committees of the Society that have completed their labors be discharged with the thanks of the Society, and that such committees be continued with such change in personnel as the new President may see fit to make.

The motion was seconded and carried.

President Hoffman: There is a motion and second before the house that the work of the Auditing Committee be accepted and that the committee be discharged.

The motion was put to a vote and carried.

Mr. Quay: If it is the proper time I move that all unfinished business be referred to the incoming Board of Governors.

The motion was seconded, put to a vote and carried.

President Hoffman: The Chair will appoint the following men to escort the President-elect to the Chair: Prof. Carpenter and Mr. William M. Mackay.

The committee escorted President-elect Bolton to the chair.

President Hoffman: The same committee will escort the Vice-President-elect to the platform.

The committee escorted Vice-President-elect Franklin to the platform.

President Hoffman: I understand Mr. Allen, the First Vice-President, is not here. The next in order is for the committee, Mr. Snow and Mr. Hale, to escort Secretary Macon to the chair.

Secretary-elect Macon was escorted to the chair.

President Hoffman: This same committee will escort the Treasurer, Mr. Scollay, if he is here, and the members of the Board of Governors to the front.

Gentlemen of the Society: I take great pleasure in turning over the affairs of the Society to this body of gentlemen that you have just elevated to high positions to guide and instruct you for the next year. I wish to retire, thanking them and thanking you for your very great kindness in supporting me during the past year.

President-elect Bolton assumes the chair.

President Bolton: Gentlemen, in assuming the honorable duties that you have so kindly placed upon me, I do so with a great sense of the responsibility and of the opportunities that lie before us as a Society, and in the work of presiding at your gatherings, I realize the advantage that I possess in having observed the course of a predecessor, who has managed so well the affairs of the Society during the past year.

We will now proceed with the business before us.

On motion of Mr. Boyden topic No. 5 was referred to one of the committees dealing with kindred subjects, to report on it at the summer meeting.

On motion of Prof. Carpenter the remaining topics for discussion were laid over for the summer meeting.

On motion the meeting adjourned.

List of members and guests present at Seventeenth Annual Meeting, January 24, 25 and 26, 1911.

MEMBERS.

Addams, Homer	Bishop, C. R.	Chapman, F. T.
Andrus, N. P.	Bolton, R. P.	Chew, F. K.
Armagnac, A. S.	Boyden, D. S.	Clark, W. D.
Barron, H. J.	Bradbury, C. R.	Collins, L. D.
Barwick, Thomas	Brooks, H. H.	Corbett, F. J.
Berman, L. K.	Bushnell, S. M.	Cryer, A. A.
Berry, E. S.	Carpenter, R. C.	Cryer, T. B.

Curtis, J. W.
Davis, B. C.
Davis, F. K.
Davis, J. H.
Doherty, P. C.
Donnelly, J. A.
Driscoll, W. H.
Eadie, J. G.
Edgar, A. C.
England, G. B.
Farnham, G. D.
Feldman, A. M.
Forgee, F. A.
Fox, E. E.
Franklin, A. B.
Gates, H. T.
Gifford, B. T.
Gombers, H. B.
Goodrich, J. A.
Graham, Joseph
Greey, G. V.
Grimshaw, G. E.
Hale, J. F.
Hall, A. E.
Hankin, Richard
Hellerman, H. H.
Hill, N. A.
Hoffman, J. D.
Huey, George
Ingalls, F. D. B.
Jellett, S. A.
Joannis, Harry de
Karr, Theo., Jr.
Kent, William
Kiewitz, Conway
Kimball, D. D.
Lee, H. H.
Leland, F. A.
Lewis, S. R.
Lisk, J. P.
Lynd, R. E.
Mackay, James
Mackay, W. M.
Macon, W. W.
Mallory, H. C.
Marshall, A. B.
McCann, F. G.
McKiever, W. H.
Merritt, J. H.
Mobley, E. S.
Monash, M. E.
Moore, J. A.
Morrison, Charles
Munroe, E. K.
Myrick, J. W. H.
O'Hanlon, George
Parter, S. C.
Pearce, C. E.
Quay, D. M.
Rice, D. J.
Ritchie, William
Schreidt, Frank
Scollay, U. G.
Scott, C. E.
Seward, P. H.
Shanklin, J. R.
Sherman, L. B.
Snow, W. G.
Snyder, C. B. J.
Speller, F. N.
Stangland, B. F.
Teran, C.
Textorius, J. H.
Thomas, M. F.
Vrooman, W. C.
Webster, Warren
Welsh, H. S.
West, Perry
Whitten, H. W.
Wilson, F. A.

GUESTS.

Alvord, A. M.
Amkengerger, C. G.
Atwood, C. P.
Bradbury, F. C.
Braemer, William
Broderick, J. F.
Carney, J. F.
Chenoweth, W. H., Jr.
Clark, F. V.
Cushman, F. K.
Cushman, P. W.
DeLomar, J. F.
Dobson, J. B.
Duffy, T. J.
DuMond, A. A.
Elliott, J. B.
Erskin, Joseph
Fitts, J. L.
Fogg, W. R.
Fuller, C. A.
Garfield, J. B.
Gordon, T. B.
Gulick, L. H.
Hanbury, J. F.
Hatch, C. J.
Hoffman, P. A.
Hunt, R. B.
Hutchinson, J. C.
Issertell, H. G.
Johnson, William
Kattenbracker, H.
Kern, M. W.
Laning, E. K.
LeCompte, W. G.
Lord, F. H.
Loracco, J. A.
Lyle, J. I.
Maujer, A. R.
Mayo, Robert, Jr.
McCloughan, J. B.
McKee, J. J.
Miller, M. P.
Morgan, W. W.
Mosner, John
Newman, Howard
Peterson, G.
Phillips, F. T.
Polglase, D. E.
Quackenboss, L. H.
Redding, Allen
Regnvald, Gustave
Rein, Otto
Ritter, Arthur
Rouse, R., Jr.
Schmidt, G. G.
Schoof, Wm.
Seymour, C. H.
Slocum, C. A.
Stevens, E. A.
Theis, E. C.
Thompson, Walter
Towner, W. T.
Treat, E. J.
Tweedy, F. F.
Waldron, F. A.
Wattles, J. W.
Webster, E. K.
Young, C. J.

PAPERS

OF THE

SEVENTEENTH ANNUAL MEETING

New York, January 24, 1911

CCXXXII.

PIPE LINE DESIGN FOR CENTRAL STATION HEATING.

BY B. T. GIFFORD.
(Member of the Society.)

The author will endeavor to outline a method he has used in designing central station heating pipe lines as to size and capacity, and give such information and facts as he has found to be reliable, also some curves which he has found to be trustworthy.

It is not the intention to convey the idea that this method is the most perfect, but rather to explain the method with the hope of bringing out a discussion along the lines of this paper.

In the design of a central station heating plant two things must be definitely determined: the location of the central station and the amount and location of the business to be served. The location of the power house should be governed by the location of the territory to be served, also the urgent need of a switch for fuel purposes. In fact, about the same things determine the location of a heating plant as would determine the location of any central station. The business to be served is in many cases very difficult to ascertain, owing to the uncertain growth of the city, and the fact that it is necessary for financial reasons, to have, if possible, every foot of pipe line earning some return on the money invested in it. New buildings will be built and the present buildings may be enlarged, so a great deal of care and thought should be spent on this part of the design.

A method the writer has used for some time with very satisfactory results is as follows: First, prepare a map of the city drawn to scale, and of a convenient size to carry in the field, sometimes it is necessary to divide the map into two or more parts. Show on this map all streets and alleys, and the relative elevation of each street intersection. Note also the paved

streets and the kind of pavement. On the map show also each building and its location and mark the kind of building, whether business, church, residence, bank, hotel, etc., together with this, the number of feet of radiation it will require to heat each building. After this information has been secured, make a survey and a careful study of the different sections of the city, noting on the map the best sections for the central heating plant to serve, taking into consideration at all times, the future growth of the city. It is in this part of the design that experience is needed, and many times the engineer will find he has made a poor guess. The word guess is used because in many cases central heating plants have grown beyond the wildest dream of their designers.

In a good residence section of homes, owned by people of moderate wealth, ninety per cent. of the present business will be connected within five years. Any vacant lots in such a section should be considered as built up with a building to compare favorably with the surrounding buildings.

In a business section sixty to seventy per cent. of the available business will be connected within five years. This is greatly dependent upon the kind of heat to be sold, whether steam or water, and whether the buildings are already equipped for heating with steam or water. As a rule steam service is more popular in business sections, while in residence sections water seems to be more universally sought.

The rapidity with which business is connected to a plant depends upon the company managing the property, but the designer should anticipate a rapid growth in the number of consumers and the amount of business. After having determined the location and amount of business and the central station location, work on the detail design can be started.

Commence by laying in the lines on the map, in such a way as to reach the greatest amount of business on the least number of feet of pipe line. This requires oftentimes the cut-and-try method. Whether to use alleys or streets depends upon two things. First, the relative cost of street and alley construction; second, the location of the buildings relative to the street or alley. The author has found that alley construction, other things being equal, will cost fifteen to thirty per cent. more for the labor, owing to the difficulty of working in such

a narrow place. Another thing affecting the cost of construction is the pavement which has to be taken up and relaid.

In most cities the heating companies are obliged to bring their service pipes to the curb line in the street, and to the property line in the alleys. This item of expense should not be overlooked, for in a wide street the extra cost for service lines will more than eat up the saving in labor effected by street construction.

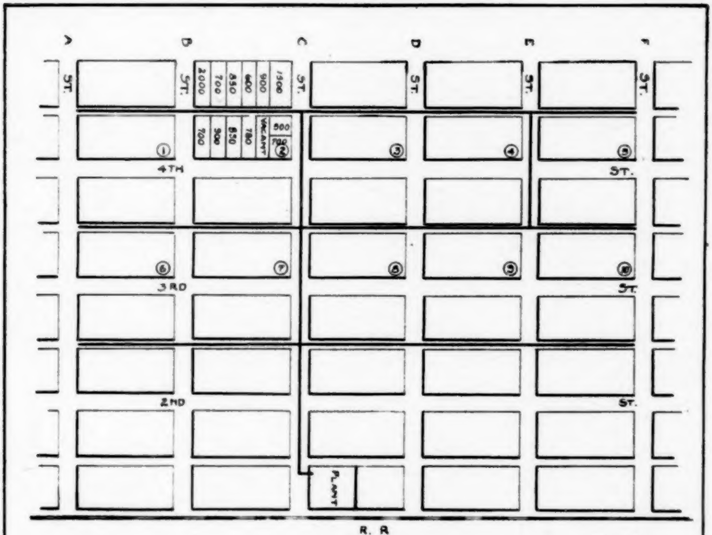


Fig. 1

We will assume for calculation a good residence section, as shown in Fig. 1, Block 2. We can assume that we will get ninety per cent. of the available business in this block, which is approximately 10,500 sq. ft. of water radiation, or approximately 6,300 sq. ft. of steam radiation.

We are obliged to allow for future extensions for Block No. 1, and possibly more yet, but in this lay-out we will assume that eventually Block No. 1 will equal Block No. 2. Block No. 2 is 400 feet long, and Block No. 3 is the same length. We have altogether 21,000 sq. ft. of water radiation to handle, but some of it will be taken off in the first 100 feet, and about

twenty-five per cent. of it will be served by the time we reach the centre of Block No. 2, twenty-five per cent. more will be taken off by the time we reach B Street, and twenty-five per cent. off when we reach the centre of Block No. 1. The last twenty-five per cent. by the time we reach the west side of Block No. 1.

In designing a central station hot-water pipe line, the author has found it better practice to throw most of the line friction in the trunk line and to have the friction loss in the laterals very small, and to make the friction loss in the laterals in proportion to the circulating pressure (difference in pressure) at the point the lateral begins. As example we will assume that at the point of the lateral for Blocks No. 1 and No. 2 the circulating pressure is five pounds. Now we must have at least one pound of circulating pressure at the end of the lateral, therefore we can lose four pounds in friction between the ends of the lateral, or one pound per two hundred feet, which is five-tenths of a pound per one hundred feet. We then have the following condition:

First	200 ft. of line must handle..............	21,000 sq. ft. of radiation
Second	" " " " " "	15,750 " " " "
Third	" " " " " "	10,500 " " " "
Fourth	" " " " " "	5,250 " " " "

From curve No. 1 we find a six-inch pipe will handle 21,000 sq. ft. with this friction loss, and five inch will handle 15,750 sq. ft., a four and one-half pipe will handle 10,500 sq. ft. with a one-half pound loss, and a three and one-half-inch pipe will handle 5,250 sq. ft. of radiation with this friction loss.

A rule the author has followed is to never run a smaller water main than three inch in the initial lay-out, this will always allow for some future extensions.

In figuring a branch line off of a lateral, consider the circulating pressure at the point the branch leaves the lateral, as the originating pressure and one pound as the circulating pressure at the end of the branch. Some very interesting problems are found in this work.

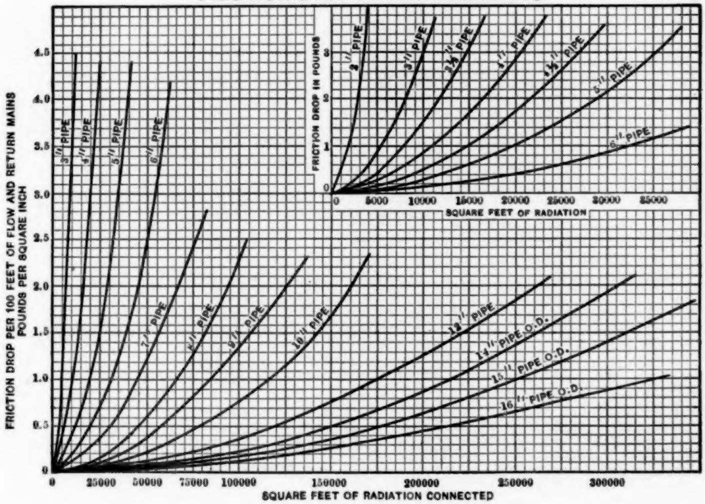
The author advocates the use of pipe bends instead of elbows or fittings in the lateral lines.

There has been a practice made use of by some engineers to run a larger return line than flow line, for instance, a three-

inch flow and a four-inch return line. This method, it is claimed, gives a more equal circulating pressure all over the pipe line system. The author has found that by limiting the heavy friction loss to the main trunk lines, that this objection is as equally well overcome and the investment is slightly reduced.

In designing a central station steam pipe line the same general plan is used. In this case, however, the friction loss

FRICTION DROP IN HEATING MAINS



CURVE I.

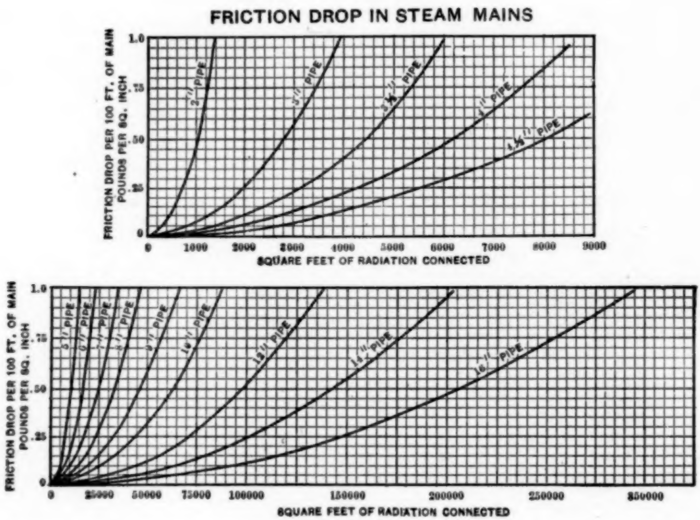
is dependent upon the maximum back pressure allowed on the engines if connected as a by-product plant. A live steam central heating plant should be designed along the same general plan as a hot-water heating system, with twenty-five pounds as the maximum pressure on the pipe line. Curve No. II shows the curves used for the steam pipe capacities.

Let us assume the same territory, viz., Blocks No. 1 and 2, to lay out a steam-heating pipe line. In this case we will also assume that the original pressure, where this line begins, is three pounds. We will want at least one pound pressure at the end of the line. We can, therefore, lose two pounds in friction. This

allows us 0.25 lb. per 100 feet. In the case of steam pipe line we have the following conditions:

First	200 ft. of line must handle............	12,000 sq. ft. of radiation
Second	" " " " " "	9,000 " " " "
Third	" " " " " "	6,000 " " " "
Fourth	" " " " " "	3,000 " " " "

From curve No. II a six-inch line will handle 12,000 sq. ft. of radiation, a five-inch line will handle 9,000 sq. ft., but the friction loss will be too great (0.54 lb.), therefore we will con-



CURVE II.

tinue the six inch 100 feet beyond the first section, viz., 300 feet in all, and the last 100 feet we will make five inch. A four and one-half inch line will handle the third section of 6,000 sq. ft. of radiation and a four inch will suffice for the last section handling 3,000 sq. ft. As in the case of hot-water heating, there should be a minimum size to install as a main and in steam heating the author has fixed upon four inch as a minimum. The above pipe sizes are figured with the steam and condensation going in the same direction. If going in opposite direction a greater friction loss will be sustained.

There are, of course, other methods of designing central

station pipe lines somewhat more elaborate and a great deal more lengthy, but the method outlined is accurate for any central station lay-out, and has the advantage of being rapid as well as reliable.

The detail of the construction, such as insulation, method of handling, expansion and contraction anchors, taps, drainage, etc., will not be considered here, although the capacity of a given sized line is seriously affected by faulty construction, and this point should be carefully considered.

DISCUSSION.

Mr. Bishop: I think the details given are faulty, and very misleading, in that no allowance is made for effects of drop in pressure and loss in carrying capacities due to good or to poor insulation. Certainly you would not expect to run a line of pipe in the open air uninsulated, and secure satisfactory service, and be able to deliver the quantities of steam named. The author should have assumed some loss per square foot in the underground line, referring to it as transmission loss. He should have also assumed, I think, in order to make the table of any value, either some quantity of B.t.u. thrown off per sq. ft. of radiation per hour, or some quantity of steam condensed per sq. ft. of pipe surface per hour at the pressure named, 3 lb.

Looking through the table I note that a 6-in. hot water pipe will handle 21,000 sq. ft. of radiation, after allowing for the friction loss assumed by the author; while in a following table he states that a 6 in. steam main (friction allowed) would provide the necessary steam to take care of only 12,000 sq. ft. of radiation—a little more than half as much; while in curve II he shows that a 6-in. steam main with a one lb. drop will provide for about 23,000 sq. ft. of steam radiation; thus his figures become inconsistent.

I think it is quite necessary to apply some factor of insulation efficiency, in connection with the table of delivery losses, to determine the quantity of steam that can be conveyed in pipe of various diameters, and, further, to eliminate "square feet of radiation to be served," substituting "pounds of steam" to be delivered.

Mr. James Mackay: I would like to ask Mr. Bishop what is

his practice as to size given for amounts of radiation and how he would estimate the friction loss.

Mr. Bishop: In designing an underground steam distribution system, I use the capacity tables which have been worked out by the American District Steam Company. When their present method of construction and insulation was first experimented with, a table of capacities was evolved for the various sizes of supply mains, operated under pressure of from 5 lb. to 50 lb. above atmospheric pressure, per sq. in. Records since then have been constantly kept, and necessary changes in the capacity tables have been made. During the past five years or more practically every central station steam company has begun operation under the meter system of charging, and many companies have adopted the meter system who, previous to the time of the perfection of a recording meter, had been furnishing steam under the flat rate system of charging. The records supplied by these companies have shown beyond any possibility of argument that the quantity of steam condensed per sq. ft. of radiation, under exactly similar weather conditions, varies tremendously. The consumption of steam per 1,000 cu. ft. of space heated, under similar weather conditions, and with relatively the same glass and wall exposure, and same building construction, shows less variation but differences of at least 100 per cent.

These conditions being known, all reference to quantity of radiation to be connected is ignored, and all calculations pertaining to sizes of supply mains to be installed are made with reference to the quantity of steam to be delivered under a predetermined pressure and with pressure losses of one-half lb. per 1,000 lineal feet of underground mains.

Mr. Donnelly: The author states that when the steam is going in the opposite direction to the drainage of condensation, a greater friction loss would be sustained. I can give some figures on that. If the steam is flowing in the pipe and the condensation is coming in the opposite direction, we expect a reasonable pitch in the pipe. It is possible to figure very closely the head of water which must be maintained in order to balance the velocity head of the flow of steam.

This is a very nice illustration of the conversion of a velocity head of steam into a static head of water. For instance, if the velocity head is 16 ft. per second, which is higher than one-pipe

radiator practice, the head of water necessary to balance the velocity head would be about 0.03 in. A smaller head of water would result in the water being blown back until the water accumulated and balanced it. The water would then have to rise somewhat higher in order to flow in the opposite direction. This head of water becomes more serious in pipes of small size and much more serious with higher velocities. With a velocity of 32 ft. a second, it is 0.12 in. With 64 ft. a second, which is not getting up very high, it is 0.48 in. With 128 ft. a second, which is quite high, it is 1.92 in. That would be the minimum height of the condensation which would balance the velocity head of the steam in the opposite direction.

To my mind, one of the most necessary things to know, in connection with circulating steam, is what these velocities should be for different-sized pipes. We should know the sort of drainage we are getting, and when the condensation is being blown up the riser and when the condensation is really running back. I have visited plants where the specifications read that the water of condensation should run back against the flow of steam, and where the water did not run back at all, but was carried in the opposite direction to some drip point.

Mr. Jellett: One other factor enters into the problem of the central heating station, and that is whether the measurement is by meter or per sq. ft. of radiating surface served. My reason for saying so is that I was employed not very long ago to make an examination of a central heating station. The heating equipment covered quite a large area. As they had changed from an annual charge based on per square feet of radiation to the meter system, the whole town was up in arms, and we were employed by the members of a property owners' association to determine whether the charges were fair or otherwise. When we commenced to collect data we found that some houses, which had 600 or 700 sq. ft. of heating surface, were actually condensing much more than other houses with 1,500 sq. ft. of heating surface. I therefore sent men out to count the number of open windows in the morning, when rooms were being aired, and I found that the occupants of a number of the small houses, because they had been in the habit of buying heat by the year, used all they pleased, and nobody ever thought of shutting any of the valves or closing any of the windows. The meter tests

showed not over three per cent. variation from the standard. So we notified the citizens' committee to issue a printed set of rules to the members, urging them to use the same reasonable care as though they were using coal from their own coal bins, and they would not have so much fault to find with the central station.

Mr. Bushnell: The company with which I am connected in Chicago has for the past ten years had the work of handling and operating heating plants. Some of them have been installed under the direction of some of the engineers in this Society, while we simply operate them after they are installed. Accordingly we meet with a good many points which develop under actual service conditions.

I notice in reading over this paper of Mr. Gifford's that he has arrived at the same conclusion that we have in our underground work in Chicago, namely that with the average underground pipe line system 25 or 30 lbs. steam pressure is about as high as is advisable where you cannot get at the pipes. With higher pressures than that, it is necessary to have a tunnel system, so that the bends and connections may be inspected and, if necessary, be repaired from time to time.

Another matter that I was interested in is his point that the laterals should have the least drop. That is a rule which we have used for years in connection with wiring distributions, allowing the main drop in the trunk line and figuring on a very small drop in the laterals. I believe that as the distribution of steam gets to be on a more scientific basis, some of the rules which have been worked out in electrical distribution will be found to apply in a similar manner to the handling of steam.

Another point mentioned corresponds exactly with our own experience. We have served quite a number of buildings for the past few years, on which we have kept a careful record as to the cost of heating. On a number of these we have checked up the cost with the amount of radiating surface. We find that the amount of heating units required per year per square foot of radiating surface installed varies over 100 per cent. Accordingly we have practically abandoned the idea of trying to figure our heating estimates on the basis of the number of square feet of radiation installed.

CCXXXIII.

REPORT OF COMMITTEE ON RATING OF HEATING BOILERS.

The work done by the Committee on Rating of Heating Boilers has been in accordance with the following vote of the Society: "*Resolved:* That it is the sense of this Society, that in the absence of any standard for rating of steam and hot water heating boilers, one should be established, based on coal consumption per square foot of grate surface and efficiency."

In order to determine the method of rating, it is first necessary to decide what unit will be used as the output of heating boilers, and this Committee recommends that a square foot of direct heating surface be used as the unit of rating, based upon the assumption that a foot of direct steam heating surface gives off 250 B. t.u. per hour, and that a foot of direct water heating surface gives off 150 B. t. u. per hour.

In order to determine the output of any heating boiler in the form of heat it is necessary to know the heat value of the coal burned, the rate of combustion, and the efficiency of the boiler. This Committee considers that it is within the province of this Society to recommend a standard heat value for coal, upon which ratings shall be based, and recommends that 12,000 B. t. u. per lb. of coal be that basis.

This Committee considers that it is not within its province to fix arbitrarily either the rate of combustion for different sizes and makes of boilers, or the efficiency of different sizes and makes of boilers, believing that both of these are functions of the manufacturer. Consequently, this Committee suggests that all ratings of heating boilers, in order to be in accordance with the standard of The American Society of Heating and Ventilating Engineers, shall be based on the square feet of steam radiation or water radiation, with the values given above, accompanied by a definite and stated rate of combustion and of boiler efficiency in each case. It must be understood that the ratings,

whether based on steam or hot water surface, include not merely the actual radiators connected, but what might be called the "equivalent value" of all radiating surfaces, including piping, valves, etc., beyond the supply nozzle of the boiler and back to the return outlet of the boiler. The reason for suggesting the use of square feet or direct radiation as the basis instead of the B. t. u. is that there is thus avoided a change from the present established methods, to which the layman buyer is largely accustomed, to a unit with which the layman is very much less familiar, and which is, consequently, more puzzling.

It may be objected that this seeming simplicity of method is at the cost of a failure to take into account all the variable conditions, such as temperature of flue gases, power of draft, temperature of feed water, pressure at which steam boilers are run, etc., but in this connection it is to be noted that the efficiency of the boiler, which is to be stated by the manufacturer, necessarily takes into account all of these things. This Committee considers itself as not warranted in going further than to suggest that the efficiency should be uniformly based on two pounds of steam pressure per square inch for steam boilers and on 180 degrees Fahr. supply temperature for water boilers, and should assume ordinary gravity return in each case. It is the opinion of this Committee, however, that the exact conditions under which the efficiencies are to be based should be definitely determined by the Society, just as the conditions under which power boiler tests shall be run and the results recorded, have been determined by the American Society of Mechanical Engineers, but this Committee believes that this work should be undertaken by a separate committee on Testing which should be engaged on this particular standardization alone.

Attached hereto will be found a table showing ratings per square foot of grate surface, for boilers of different efficiencies with different rates of combustion. This table has been prepared to show the range over which ratings may vary with various rates of combustion and efficiencies.

In accordance with the above this Committee makes the following recommendations:

1. That the unit of output of heating boilers be a square foot of direct steam radiation, assumed to give off heat at the rate of 250 B. t. u. per hour, or a square foot of direct hot water

radiation assumed to give off heat at the rate of 150 B. t. u. per hour, and that for the purpose of determining the load of any boiler, all of the radiating surfaces, of whatever nature, be reduced to "equivalent direct steam" or "equivalent direct water radiation."

2. That all ratings of heating boilers be accompanied by statements of the rate of combustion in pounds of coal per square

RATINGS OF CAST IRON BOILERS IN TERMS OF SQUARE FEET OF DIRECT STEAM RADIATION PER SQUARE FOOT OF GRATE AREA, WITH DIFFERENT RATES OF COMBUSTION AND DIFFERENT BOILER EFFICIENCIES.

Assumptions.—(a) Coal heat value = 12,000 B. t. u. per pound; (b) boiler efficiency = ratio of heat given off beyond nozzle to heat-value of coal burned; (c) one square foot of direct steam radiating surface gives off 250 B. t. u. per hour.

Note.—All radiating surface giving off different amounts of heat than 250 B. t. u. per hour per square foot may be reduced to "equivalent direct surface" at 250 B. t. u. per hour per square foot for use in connection with this table.

Lbs. of Coal per Sq. Ft. of Grate per Hr.	BOILER EFFICIENCIES. (Per Cent.)										
	50.0	52.5	55.0	57.5	60.0	62.5	65.0	67.5	70.0	72.5	75.0
	SQUARE FEET OF DIRECT RADIATION.										
1	24.0	25.2	26.4	27.6	28.8	30.0	31.2	32.4	33.6	34.8	36.0
2	48.0	50.4	52.8	55.2	57.6	60.0	62.4	64.8	67.2	69.6	72.0
3	72.0	75.6	79.2	82.8	86.4	90.0	93.6	97.2	100.8	104.4	108.0
4	96.0	100.8	105.6	110.4	115.2	120.0	124.8	129.6	134.4	139.2	144.0
5	120.0	126.0	132.0	138.0	144.0	150.0	156.0	162.0	168.0	174.0	180.0
6	144.0	151.2	158.4	165.6	172.8	180.0	187.2	194.4	201.6	208.8	216.0
7	168.0	176.4	184.8	193.2	201.6	210.0	218.4	226.8	235.2	243.6	252.0
8	192.0	201.6	211.2	220.8	230.4	240.0	249.6	259.2	268.8	278.4	288.0
9	216.0	226.8	237.6	248.4	259.2	270.0	280.8	291.6	302.4	313.2	324.0
10	240.0	252.0	264.0	276.0	288.0	300.0	312.0	324.0	336.0	348.0	360 0

Example of Use of Table.—If 4 pounds per sq. ft. of grate per hour are burned under a boiler, the efficiency of which is 60% with 6 sq. ft. of grate, what will be the capacity of the boiler? From the table, the radiation surface per sq. ft. of grate = 115.2 sq. ft., so that the total for 6 sq. ft. of grate = 691 sq. ft. of direct steam radiation.

foot of grate and of the efficiency of the boiler; the grate area to be the mean area of the fire grate and the efficiency to be the ratio of the total heat units given off between the supply nozzle of the boiler and the return outlet, to the total B. t. u. assumed to be given off by the combustion of the coal, on the basis of 12,000 B. t. u. per lb. of coal.

3. That the Committee on Tests be requested by the Society to standardize the conditions under which the efficiencies of heating boilers shall be determined in accordance with the above definition.

4. That the Society take steps to obtain the coöperation of boiler manufacturers in adopting the above recommendations in the rating of their boilers; that is, to have all boiler manufacturers rate their boilers as suggested above and publish the rate of combustion and the efficiency of the boiler for each rating.

Respectfully submitted,

Edw. D. Densmore, *Chairman,*
Reginald P. Bolton,
James Mackay,
James A. Donnelly,
Ralph Collamore.

DISCUSSION.

Mr. Harding: The matter of the intrinsic worth of any product is capable of being figured out. The matter of its commercial worth is another thing entirely. The matter of psychology enters in when you go into the commercial proposition, and when you come to get a rating for a boiler that is to be sold in the market, commercially, you differentiate very largely from the technical and the engineering and the exact qualifications for that particular boiler. And when we endeavor to base the capabilities of a boiler upon the matter of B. t. u. in its efficiency, in the consumption of fuel, then there is an uncertainty.

We all recognized this during the time of the coal famine, when the Philadelphia & Reading Coal and Iron Company delivered to us a coal containing many less B. t. u. per ton than we used to get in the earlier days. And it is difficult to find a standard upon which to base capacity, the ability to generate steam per square foot of grate, for instance.

I have found in my own personal experience that for the average quality of coal, in a boiler of fairly good construction, with a reasonable amount of direct fire surface, flue surface and grate surface, the only safe proposition is to assume that best results will be obtained on the basis of 8,000 B.t.u. per lb. of coal delivered to the radiating surface; assuming that uncovered pipes and pipe risers are figured as radiation; that every distributing pipe, either a riser or a main, is covered with a good non-conducting covering. And I say that 8,000 B.t.u. is the only safe value upon which the manufacturer or the engineer in the

business of installing that character of plants finds it safe to calculate; assuming that every square foot of radiation, in a temperature of zero, with a temperature of 219 or 220 deg. in the head pipes, will radiate 276 B.t.u. per hour.

Let us assume, for instance, that a boiler that contains anywhere from 3 to 5 sq. ft. of grate area will not consume more than from 4 to 4½ or 5 lbs. of coal per sq. ft. of grate per hour; and as we increase the size, not over say 7 pounds of coal per sq. ft. of grate per hour. Within those limits let the committee define what constitutes a properly constructed boiler. I think that 8,000 B.t.u. per lb. of coal is the limit, that it is safe to go, with the average quality of coal that we get out in Pennsylvania from the anthracite vein.

Prof. Kent: There seems to be a large difference between 12,000 B.t.u. in the paper and 8,000 mentioned by Mr. Harding. I think it may be the result of taking this table of 12,000 B.t.u. as the heating value of a pound of coal, and by assuming 61 per cent. efficiency, we have 8,000. That is what we will get from ordinary everyday practice, including loss of radiation from the line pipes to the radiating surface. So there is not much difference after all. I regard this figure of 12,000 B.t.u. per lb. as good a figure as can be got; that is, anthracite coal will run from 14,800 to 15,000 B.t.u. per lb. of combustible, the last figure being some of the anthracite of the Lykens Valley, which runs rather high in volatile matter. Assuming 15,000, and taking off 20 per cent. for ash and moisture, gives 12,000; now 20 per cent. is surely enough to allow for moisture and ash in coal that would be used in house-heating boilers. It may be they are using poorer coals, such as buckwheat and rice, in large electric light plants. A higher figure than 8,000 (say 9,000) can be adopted for egg coal, but not much egg coal is being used now; it is too high priced. I think the table given by the committee is a fine piece of work. I am very much pleased with the report of the committee and hope it will be generally approved.

Mr. Quay: The committee have referred to the efficiency of boilers in a number of places in the paper. The efficiency of a low pressure heating system is affected a good deal by the efficiency of the boiler. I would like to ask the chairman of the committee if they have any definite information or have made any tests to learn what is the efficiency of low pressure heating

boilers in common use, without referring to any one in particular.

One reason this matter should be considered is that certain manufacturers of air tube heaters used in connection with fans claim they obtain from 80 to 85 per cent. efficiency at the outlet of the fan. If this is true, it might be well for us, as engineers, to compare these systems with the usual low pressure heating systems as to efficiency. With a high pressure tube boiler we often specify 70 per cent. efficiency. It takes a pretty good water tube boiler to give that percentage; and the boiler manufacturers require that coal shall contain about 14,000 B.t.u. per lb. in order to guarantee this result.

Mr. Snow: I see nothing in this report that would answer Mr. Quay's question. That matter was incorporated in the report that was handed in by the committee which preceded this one, not as an essential element of its report, but simply as a matter of information, showing the estimates of a number of members of the Society as to what the efficiency of boilers should commonly be considered under average working conditions.

The committee this year has apparently boiled this whole matter down to its simplest terms and stripped it of all unnecessary features. There has been a great deal left out, and yet there appears to be enough in the report to satisfy the requirements of an engineer in the selection of a boiler. If he can secure from the manufacturer information along the lines suggested in this report, he ought to be able to make an intelligent selection.

There is nothing in this report that mentions the period of firing; but I am inclined to think that the rate of combustion goes hand in hand with the period of firing; and that therefore we do not necessarily need to bring that element in.

I note the report says: "In accordance with the above, this committee makes the following recommendations for adoption by the Society." I would be in favor of striking out the words "for adoption by the Society." If the Society receives the report it is sufficient. It is not necessary to adopt it, and, further, it is contrary to the practice of similar societies to adopt reports. Our Society goes on record as having received the report, and if by common consent it is accepted by engineers at large it will become known as the A. S. H. & V. E. standard.

Prof. Kent: I second the motion to strike out the words "for adoption by the Society."

The motion was put to a vote and carried.

Mr. F. K. Davis: An interesting bulletin has been issued by the United States Geological Survey giving the records of tests of house-heating boilers. The tests that were made and published are on two makes of boilers that are commonly used in house heating. I learned from the Bureau of Mines last week that they are now testing other boilers that are in use. In the two that were tested I was surprised to find that in no case did they exceed 63 per cent. efficiency. That was the highest obtained at any test, and that was obtained, if I remember correctly, on about four and a half lbs. of coal per sq. ft. of grate per hour. The efficiencies dropped from 63 per cent. to about 45 per cent. The average was somewhere around 55 per cent. As they increased the coal consumption per sq. ft. of grate over say four to four and a half lbs., depending on the different sized boilers, the efficiency dropped. Now it seems to me that if the test showed an average say of 55 per cent. on four or four and a half lbs. of coal, it looks pretty hard to get 70 per cent. on seven lbs. I have tried in the last year to get some data on coal consumption of different boilers, and I find that the rate of combustion, if an attempt is made for efficiency, is a great deal lower than is naturally supposed; and, in fact, in my work, and with eight and nine lbs. per sq. ft. of grate, the efficiency is always very low.

Mr. Barwick: I have used for a number of years the standard of six lbs. of coal per sq. ft. of grate per hour, basing my calculations for the radiators at 275 B.t.u. per sq. ft. of radiation. That standard brings us about 70 per cent. efficiency, figuring the actual square feet of grate surface only, and taking ordinary boilers as constructed at present by different manufacturers.

I find that many of the boilers that are made at the present time have sufficient flue surface, sufficient surface for the conductivity of the gases from the fuel and also for the furnace radiation. Even those that have been on the market for the last twenty years do as well as some of those that are put out at the present time as something a great deal better. So I believe that the rates as shown in that list at the present time are fair. I believe that taking 12,000 B.t.u., with a standard of 60 per cent., is a fair basis for a boiler of the sizes stated.

Mr. Barron: I would like to get an interpretation of the note

at the bottom of the table. It says, "Example of use of table.—If 4 pounds per sq. ft. of grate per hour are burned under a boiler, the efficiency of which is 60 per cent., with 6 sq. ft. of grate, what will be the capacity of the boiler? From the table, the radiation surface per sq. ft. of grate equals 115.2 sq. ft., so that the total for 6 sq. ft. of grate equals 691 sq. ft. of direct steam radiation." Now I would like to ask the members of that committee, or any practical heating man here, if the general practice is not to put in a boiler with 6 sq. ft. of grate and put in about 900 square feet on it, including mains, for low pressure steam heating?

Mr. James Mackay: That I believe is simply explanatory. It does not intimate that any and all boilers of that grate area should be rated at 690 sq. ft. It simply gives an example. Now you might have a boiler of a great deal higher efficiency—and I think that the boiler that Mr. Barron speaks of, as able to carry 900 square feet, is a boiler of a good deal higher efficiency than is given in this footnote. This simply speaks of 60 per cent. to illustrate the use of the table.

There were no tests made for efficiency. Different efficiencies are given here with tables corresponding, and there are boilers on the market such that the efficiency will be guaranteed equal to 70 per cent. I have made tests and gotten over 60 per cent. with an ordinary boiler; and Mr. Densmore compared notes with other members of the committee and compiled the list as the result. There is nothing about this efficiency that is arbitrary. If a boiler has only 50 per cent. efficiency you have to consider that. Similarly if it should have 70 per cent. That depends on the manufacturer.

Mr. Barron: I am much obliged to Mr. Mackay for his explanation, but the point I want to get in our proceedings is that I had not any particular type or character of cast-iron boiler in mind, but I was simply speaking of average conditions. I would not like it to go out that the young engineer could take this table and make deductions from it, and that possibly 6 sq. ft. of grate was good practice, when you come in contact with so much that is opposite to that. My idea is that average practice exceeds 60 per cent.

Mr. Snow: The committee merely by chance selected the illustration. They could have selected any other just as well; and

if they had gone to the last column and selected 75 per cent. as an illustration, they would have come out with a boiler of 864 square feet, which corresponds to the boiler Mr. Barron mentions. They do not go on record however as selecting any definite thing. This is taken simply as an illustration, so that does not commit us to anything or to any particular type. I feel that we have "arrived" in this matter. We have been at it for years and have finally reached a very simple basis, if you want to put it that way. In other words, we have been looking for a datum, something to figure from. If this meets with the approval of the Society and it is received and placed on file, it gives us a basis to figure from, so that every one will be figuring on the same basis. That is what we have been driving at for a long time, to get down to a standard. And I am enthusiastic for this report, and I trust that the Society will receive it.

CCXXXIV.

THE DURABILITY OF WELDED PIPE IN SERVICE. *

BY FRANK N. SPELLER.

(Member of the Society.)

In again opening this much worn subject for discussion before this Society, it is my intention to touch on the results of recent investigations, which it is believed have a most practical bearing on this important matter.

Before proceeding, let us for a moment review the fundamental reactions involved in the corrosion of iron, so as to have a clear conception of what is going on when, as we say, a pipe rusts. The most satisfactory theory of corrosion is based on the fact that iron is slightly soluble in water, a property common to nearly all materials in nature. In itself this is not of serious consequence, since the quantity dissolved is so extremely small. Moreover, when iron is dissolved the water gives up an equivalent amount of its dissociated hydrogen, which is, so to speak, plated out on the surface of the iron, causing polarization and retarding further solution of the metal. Solution is further retarded by the water becoming saturated with iron as ferrous hydrate.

If we are dealing with water free from dissolved oxygen or acids, an equilibrium is thus soon established, but if oxygen is present it combines with the free hydrogen on the surface of the iron, exercising thereby a depolarizing effect and allowing more iron to go into solution. The ferrous hydrate in solution is oxidized to insoluble ferric hydroxide and precipitated as rust, thus leaving room for more iron to pass into solution. Therefore, provided a continuous supply of oxygen is at hand, corrosion continues until the pipe is destroyed. Other things will accelerate the reaction, such as the presence of stray electric currents, increased galvanic action on the surface of the metal, the action of

* Since writing this paper Dr. Walker's investigations on the corrosion of iron and steel pipe have been published in the *Journal of the New England Water Works Association*, March, 1912.

acids, etc., but practically speaking, in the case of water pipes, the amount of corrosion is nearly proportional to the quantity of oxygen brought in with the water, so that water free from dissolved gases is usually quite harmless and will not even discolor the bright surface of iron after years of exposure. It also holds true that air free from moisture is equally inactive and will not cause rusting; but we are not concerned with this phase of the problem.

The elementary reaction of corrosion being one of solution, the physical condition of the metal, uniformity in composition, and the nature of the protective coating evidently have an influence on solubility of iron and, therefore, on the rate at which rust will form. These are points to which the leading interest in the manufacture of steel pipe has paid considerable attention for several years past, since the practical significance of these things has been better understood. It is important to remember, however, that solution starts on the *surface,* and therefore that accidental differences in the condition of the surface may be much more influential in promoting solution of the metal than irregularities in the metal itself. This applies particularly to mill scale which forms with iron a galvanic couple having a potential many times greater than the worst possible case of segregated or irregularly distributed impurities found in the metal.*

Many who have observed the increased destruction of piping and other metal products nowadays have concluded that there

***Engineering News,* December 8, 1910.

"In order to see if there was any relation between the quality of the material judging by the chemical analyses and the local pitting due to corrosion, we selected two pieces of what turned out to be wrought iron pipe from the same line, one sample of which (No. 44) was comparatively free from corrosion, while the other (No. 45) was badly pitted all over. The analyses of drillings taken from these samples are given below:

No. 44		No. 45
.160%	Phosphorus	.120%
Trace	Manganese	.13
Trace	Carbon	Trace
2.95	Oxides	3.40

"In another case a piece of wrought iron was found to be pitted in a few places, but by far the larger portion of the inside surface was free from corrosion. Analyzing the pitted and the clean surface we found the following composition:

	Sample No. 1		Sample No. 2	
	Around Pits	Clean Surface	Around Pits	Clean Surface
Sulphur..........	.023%	.019%	.021%	.020%
Phosphorus.......	.370	.310	.337	.315
Manganese.......	Trace	Trace	Trace	Trace
Carbon...........	Trace	Trace	Trace	Trace
Oxides...........	2.75	3.00	2.80	3.00

"This does not indicate any significant difference in composition. The explanation for the difference in effect on materials like the above, which have practically the same composition, is evidently that the surface exposed to the water was in one case better protected than in the other by the mill scale which naturally forms in the process of manufacture."

must be something radically wrong with the material of which these things are now made. A few years ago the cry was raised, and it is still maintained from some quarters, "Give us wrought iron, so that the pipe will last." On the other hand, numerous experiments have been made by independent authorities under conditions fundamentally those of service, which, on the whole, show no practical difference between wrought iron and steel, although these tests have indicated some important principles which should be observed in the manufacture of steel where corrosion has to be considered. The experiments we refer to, of which those made by Prof. Howe and Mr. T. N. Thomson are examples, were sometimes conducted in the laboratory by immersing pieces of the metal in aerated water, and in other cases pieces of various kinds of pipe were actually put in service together for a certain period and the corrosion measured. It has been the business of those specially interested in making wrought iron pipe to decry all such comparisons, although no contrary facts are offered; their case being based simply on the fact that wrought iron pipes put in years ago have given longer service in some cases than the steel pipe which has come into more general use in later years. This argument should not carry weight with the architect or engineer who considers the variable conditions under which pipe is used. There are many cases where wrought iron has been in service thirty years, and others where equally good wrought iron did not last two years—and much wider ranges of life are on record.

What, then, constitutes a satisfactory test? The wrought iron interests say the materials must be in service for years until they are destroyed. We agree, provided that both materials have been in *continuous service together,* as the pipe may last fifty years or but fifty days in service, depending on surrounding conditions. Experience based on other than such strictly comparative cases is worthless and misleading. The author, knowing that in the past fifteen years iron and steel pipe have been made and sold side by side, undertook some investigations to see whether the iron and steel had been by chance installed together in the same lines. Obviously, this would give an ideal comparison, especially in the case of water lines.

Let us consider for a moment the results of a study of pipe removed from hot water supply lines in the New York City

baths, which was undertaken by Professor Ira H. Woolson, formerly of Columbia University, now Consulting Engineer of the National Board of Fire Underwriters. Briefly, he found that out of 86 pieces in eight bathhouses, which had failed through corrosion, 23 per cent. were wrought iron, a larger proportion than might be expected judging by the relative proportion of wrought iron to steel on the market. In cases where pieces of iron and steel were removed from the same line they were found to be equally corroded. The samples shown are cases in point.

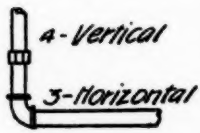
We recently had an opportunity to examine the boiler feed water pipe at the mines of the Frick Coke Co., which had been giving trouble in this way. Means were found to identify the pipe without removing it from the system. As anticipated, we found a number of cases where wrought iron and steel pipe had been put in together. Samples of such pieces were removed and cut open for examination. The results of corrosion were expressed in terms of the depth of the deepest pits, as was done by Mr. T. N. Thomson in his interesting experiments in hot water service lines. The results, so far as completed, are given in the accompanying table.

Generally speaking, these figures and inspection of the interior of these pipes show that there would be nothing to gain by using wrought iron. A similar case of comparison in a cold water line was found in a greenhouse near Pittsburgh with the same results.

We recently had an opportunity to investigate the piping in an apartment in New York City where they were having trouble with the leaking of hot water lines which had been in service about six years. The second or third piece examined proved to be wrought iron and was found in the condition shown. The other sample taken from the system through which the same water had been continually circulated illustrates how the steel was affected. This intermixture of iron and steel pipe can be explained by accidental intermixture in the manufacturers' or jobbers' stocks, and appears to be quite general.

An investigation of this question is now being conducted in the Research Laboratory of the Massachusetts Institute of Technology at Boston by Dr. W. H. Walker, on piping in New England, working along the line outlined above. It is believed that much valuable information may be obtained in this way, and the results certainly should be free from the criticisms which

No. 1



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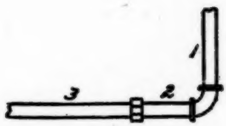

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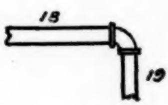

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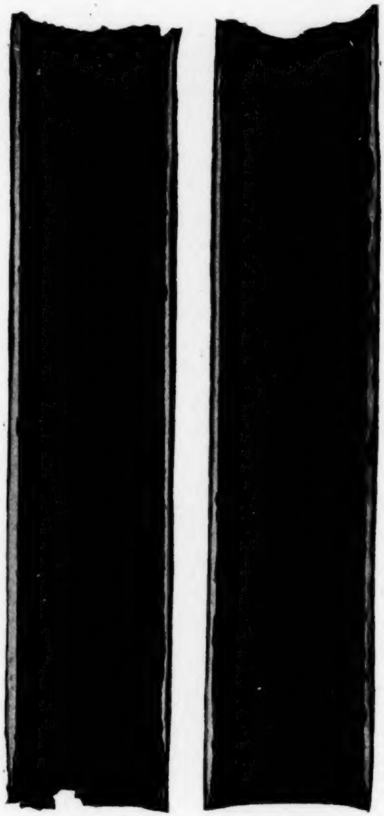
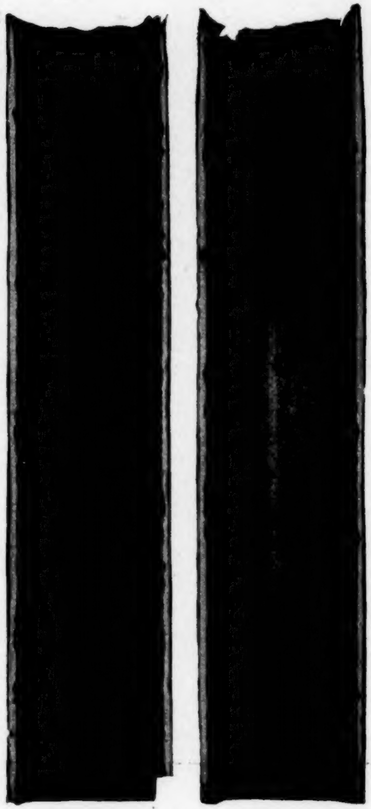


No. 24. Iron

No. 7

No. 4

SECTIONS OF PIPE REMOVED FROM HOT WATER SUPPLY LINES IN NEW YORK CITY BATHS.



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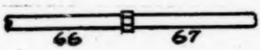

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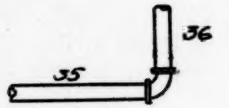

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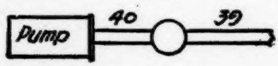

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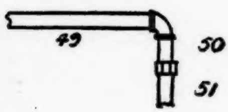

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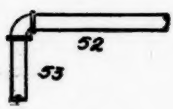

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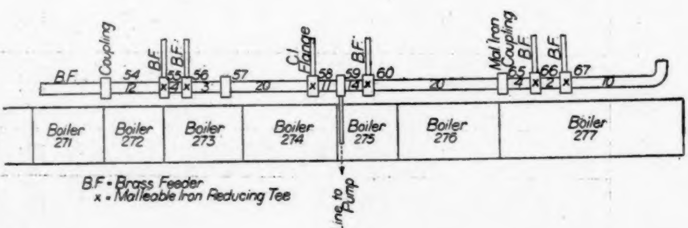

Nos. 17 to 21 inclusive

DETAIL NOTES ON CORROSION OF WROUGHT IRON AND STEEL PIPES IN SERVICE LINES.

Lot No.	Pipe No.	Material S-Steel W. I.-Wrg't Iron	Approx. Original Gauge	Pipe Size	Length of Time Installed	Approx. Portion of Time Installed That Line Was Used	Character of Service	Depth of Deepest Pits in Inches	General Condition	Percentage Depth of Deepest Pits Wrought Iron Taken as 100
1	/	S.	.2"	3"	4-5 Yrs.	Pretty Steady.	Hot Water, Boiler Feed	.112 .111 .106 .088 ..	Uniformly pitted all over.	129%
	..	W. I.	.2"	3"	4-5 Yrs.			.094	Failed at blister at thread at one end. Rest fairly good.	100
2	::	S.	.2"	3"	7½-8 Yrs.	Two-thirds.	Hot Water, Boiler Feed	.096 .076 .069	Pitted all over.	88
	∵	W. I.	.2"	3"	7½-8 Yrs.			.109 .106 .105	Pitted all over. Several other deep pits, but metal bent.	100
3	2	S.	.210"	2½"	2 Yrs.	Pretty Steady.	Hot Water, Boiler Feed Horizontal.	.107 .096 .076 .076 .076	Fairly badly pitted over most of area.	72 } Av. = 75
	3	S.	.290"	2½"	2 Yrs.			.115 .099	Other pits a little less deep, but pipe too rough to measure accurately.	77
	1	W. I.	.195"	2½"	2 Yrs.	" "	Hot Water, Boiler Feed Horizontal.	.149 .095 .060 .073 ..	3 failures at threads. Fairly badly pitted all over.	100
4	9	S.	.119"	1¼"	2 Yrs.	" "	Hot Water, Boiler Feed Horizontal.	.080 .073 .072 .072 .064	Better than No. 8.	53 } Av. for steel = 66 } Taking failure in metal as pit depth = thickness of orig. gauge.
	8	W. I.	.154"	1¼"	2 Yrs.			.150 .096 .079 .079 .079	Fairly badly pitted.	
	-9-	S.	.119"	1¼"	2 Yrs.			3 failures in metal. .096 .096	1 Flr. at thread. Pitted uniformly.	
Note:	-9- other end of No. 9.									
5	10	S.	.136"	1¼"	2 Yrs.	" "	Hot Water, Boiler Feed Horizontal.	.015	Good. Few slight pits.	14
	11	W. I.	.175"	1¼"	2 Yrs.			.107 .096 .091 .091 .076	Bad pits in a few places.	100

Lot No.	Pipe No.	Material S-Steel W. I.-Wrg't Iron	Approx. Original Gauge	Pipe Size	Length of Time Installed	Approx. Portion of Time Installed That Line Was Used	Character of Service	Depth of Deepest Pits in Inches					General Condition	Percentage Depth of Deepest Pits Wrought Iron Taken as 100	
6	18	S.	.230″	4″	2 Yr. 4 Mo.	Pretty	Hot Water,	.170	.170	.169	.167	.167	Badly pitted all over.	83	
	19	W. I.	.239″	4″	2 Yr. 4 Mo.	Steady.	Boiler Feed	.204	.192	.192	.192	.175	Badly pitted all over.	100	
Note:	No. 18	horizontal.	No. 19 vertical.												
7	24-S	/S.	.200″	4″	2 Yr. 4 Mo.	" "	Hot Water, Boiler Feed	.199	.182	.182	.168(1 Flr.)		1 Flr. at thread. Bad pits all over.	96	Taking failure in metal as pit depth = original gauge.
	24	W. I.	.250″	4″	2 Yr. 4 Mo.		Horizontal.	.208	.186	.181	.169	..	About 5 Flrs. threads. Bad pits all over.	100	
8	33	S.	.145″	2″	2 Yr. 2 Mo.	" "	Hot Water, Boiler Feed	.096	.088	.078	.078	..	1 Flr. at thread. Fairly badly pitted all over; mostly at ends.	81	
	34	W. I.	.145″	2″	2 Yr. 2 Mo.		Horizontal.	.119	.113	.108	.090	..	1 Flr. at thread. Fairly badly pitted in several places.	100	
9	36	S.	.199″	3″	2 Yr. 2 Mo.	" "	Hot Water, Boiler Feed Horizontal.	.110	.094	.092	.078	.069	No. 35 pitted uniformly all over internal surface.	126	
	35	W. I.	.204″	3″	2 Yr. 2 Mo.			.087	.074	.071	.068	.068		100	
10	38	S.	.247″	4″	3 Yr. 6 Mo.	" "	Hot Water, Boiler Feed Horizontal.	.122	.114	.111	.109	.100	Very bad pits in areas.	182	
	37	W. I.	.250″	4″	3 Yr. 6 Mo.			.067	.063	.061	.059	.048	Comparatively few pits.	100	
11	39	S.	.217″	4″	1 Yr. 2 Mo.	" "	Hot Water, Boiler Feed	.061	.039	..	..	..	Other pits of less depth, but difficult to measure.	71	
	40	W. I.	*	4″	1 Yr. 2 Mo.		Horizontal.	.086	.082	.080	.078	.075		100	
*Slightly	heavier than No.	39.													
12	42	S.	.160″	2″	1 Yr. 11 Mo.	" "		.125	.109	.105	.083	..	1 Flr. at thread. Very badly pitted all over.	207	Taking average of deepest pits of the two I. and of the two S.
	43	S.	.160″	2″	1 Yr. 11 Mo.		Hot Water, Boiler Feed Horizontal.	.118	.110	.088	.071	.066	Bad pits in some areas.		
	44	W. I.	.150″	2″	1 Yr. 11 Mo.			.058	.041	..	..	..	Except for these, very good.	100	
	45	W. I.	.153″	2″	1 Yr. 11 Mo.			.060	..	..	..	..	Several more pits, but pipe bent. Could not measure.		
				(Exact positions of each piece unknown.)											

Lot No.	Pipe No.	Material S-Steel W. I.-Wrg't Iron	Approx. Original Gauge	Pipe Size	Length of Time Installed	Approx. Portion of Time Installed That Line Was Used	Character of Service	Depth of Deepest Pits in Inches					General Condition	Percentage Depth of Deepest Pits Wrought Iron Taken as 100
13	49	S.	.246"	2¼"	6-9 Mo.	Pretty Steady.	Hot Water, Boiler Feed Horizontal.	..	..	..	..	..	Rough surface with hard scale. Fair size pits all over.	Impossible to measure pits of Nos. 49 and 50 accurately.
	50	W. I.	.232"	2¼"	6-9 Mo.	" "	Hot Water, Boiler Feed Horizontal.	..	..	..	..	..	Slight pits. Rusted uniformly all over; not much pitting.	
	51	S.	.270"	2¼"	6-9 Mo.	" "	Hot Water, Boiler Feed Horizontal.	.090	.081	.080	.080	.076	Bad pits in several areas.	
14	52	S.	.310"	4"	6 Mo.	" "	Hot Water, Boiler Feed Horizontal.	.092	.091	.090	.084	.083	Fairly bad pits scattered all over.	72
	53	W. I.	.310"	4"	6 Mo.			.128	.121	.118	.110	.101	Bad pits all over.	100
15	28	S.	.149"	2"	4 Yrs.	....	Hot Water, Boiler Feed	.089	.088	.039	Other slight pits.		Fairly bad in several areas. Rest protected by scale.	101
	29	S.	.132"	2"	4 Yrs.	....	Hot Water, Boiler Feed	.112	.101	.099	.081	.069	Uniformly pitted all over.	
	26	W. I.	.170"	2"	4 Yrs.	....	Hot Water, Boiler Feed	.089	.089	.069	.065	.059	Uniformly pitted all over.	
	27	W. I.	.172"	2"	4 Yrs.	....	Hot Water, Boiler Feed	.089	.084	.083	.075	.065	Uniformly pitted all over.	Taking average of deepest pits of two steel and five iron pipes.
	30	W. I.	.157"	1¼"	4 Yrs.	....	Hot Water, Boiler Feed	.113	.106	.106	.100	.096	Number of very bad pits in places.	
	31	W. I.	.175"	1¼"	4 Yrs.	....	Hot Water, Boiler Feed	.114	.104	.104	.101	..	Number of very bad pits in places.	100
	32	W. I.	.147"	2"	4 Yrs.	....	Hot Water, Boiler Feed	.092	.088	.081	.040	..	Fairly badly pitted in several areas. Rest protected by scale.	

Case	Pipe No.	Material	Approx. Original Gauge	Diameter	Length of Time Installed	Approx. Portion of Time Installed that Line was Used	Character of Service	Depth of Deepest Pits in Inches					General Condition	Percentage Depth of Deepest Pits (the deepest pit taken in the case of each pipe), Iron Pits taken as 100%
No. 16		(Ho	thouse Inv	estigatio	n)									
No. 17	54	S.	.297″	3″	1 Y., 3½ Mo.	Pretty Steady	Hot Water Boiler Feed, Horizontal...	.100	.100	.096	.096	.085	Fairly Pitted all over.....	87
	55	W. I.	.309″	3″	"	"		.115	.105	.102	.099	.093	Pitted all over..........	100
No. 18	57	S.	.286″	3″	"	"	"	.118	.111	.104	.104	.097	Pitted all over...........	111
	56	W. I.	.303″	3″	"	"	"	.106	.104	.099	.095	.090	Pitted through to lamination at one end; impossible to measure. Bad pits all over.....	100
No. 19	60	S.	.307″	3″	"	"	"	.123	.122	.120	.114	.111	Very badly pitted in areas.	95
	59	W. I.	.317″	3″	"	"	"	.129	.124	.124	.114	.103	Very badly pitted all over.	100
No. 20	65	S.	.313″	3″	"	"	"	.127	.120	.114	.111	.111	Bad pits scattered........	117
	66	W. I.	.315″	3″	"	"	"	.109	.098	.092	.085	.082	Very badly pitted all over.	100
No. 21	67	S.	.287″	3″	"	"	"	.089	.088	.088	.087	.068	Fairly bad pits all over....	82
	66	W. I.	.315″	3″	"	"	"	.109	.098	.092	.085	.082	Very badly pitted all over..	100

Note: These pipes removed when repairing boilers. All the old piping was removed, and there was no way of telling what position these pipes occupied or how steadily they have been used.

		Steel	Iron
Cases Nos. 1 to 21, inclusive	AVERAGE OF PERCENTAGES (CASES NOS. 13 AND 16 NOT INCLUDED), Depth of Iron Pits taken as 100.....	99%	100%
	AVERAGE OF PERCENTAGES (CASES NOS. 12, 13, 15 AND 16 NOT INCLUDED), *........................	93%	100%

*Pipes composing cases Nos. 12 and 15 were ones that had been removed before the investigation was made. It is not known what position the pipe comprising these two cases occupied in the lines, and as they may not be comparable, it is advisable to also consider the average leaving out these two cases.

have been made against most of the experimental work done on this problem, viz.: that the conditions were not strictly those of service and that the time of exposure was too short. We hope that members who have information as to where possible material for such investigation may be found will co-operate as far as possible in this work.

PREVENTION OF CORROSION IN PIPES.

If the trouble is not due to the material, why is corrosion so much more serious nowadays, and how can conditions be bettered?

Going back to the principal factor in corrosion, viz.: the air dissolved in water, it has been found that oxygen is more soluble than nitrogen, so that the proportion of the two gases in solution is about two volumes of nitrogen to one volume of oxygen, instead of five of nitrogen to one of oxygen as in the atmosphere. Pure water at normal pressure will dissolve 14.7 parts per million of oxygen at 32 deg. F. and 7.60 parts per million at 86 deg. F. At 210 deg. F. oxygen is practically insoluble. So by heating the water the solubility at normal pressure becomes less, but as water is usually heated in closed heaters under pressure, the gases are forced to remain in solution, and in this condition the water may be said to be supersaturated. It is quite possible that in this state the oxygen is more active; the more so the higher the pressure. On drawing off hot water from such a line into a glass the gas is released and may be readily seen. Experiments have shown that under normal pressure water and air are most active in corrosion between 140 and 180 deg. F.

Evidently then, if, as is the case, much more hot water is being put through service lines (particularly in large hotels, apartment houses and factories) to-day, we must expect a proportional increase in corrosion; so that, if three times as much hot water is being run through a pipe of given size under the same pressure and temperature, the pipe, instead of lasting 21 years, will only last about 7 years.

Knowing, as we now do, something of the cause and principles of prevention of corrosion, it should be possible for engineers to do much to remedy this state of affairs. Apparently, there is as little need of corrosion in pipes and tubes around

boilers and in hot water heating and supply systems as there is for smoke from a modern power plant. The author is now trying out a system for removing dissolved gases from water by heating the water to a sufficiently high temperature, preferably under normal atmospheric pressure or a vacuum, and then cooling if necessary by passing the air-free water through a form of economizer designed like a closed feed water heater in which the excess heat in the air-free water is taken up by the cold feed on its way to the heater. This provides for a continuous supply of air-free water for service lines at any temperature. The treatment may with advantage be carried out on the roof slightly below the level of the cold water standpipe. Another scheme for accomplishing the same purpose was proposed by the Royal Commission appointed to investigate the cause of corrosion in the Coolgardie (Australia) water supply main. They found after a thorough study of the situation that the steel main was suffering on account of oxygen dissolved in the water, and recommended that the supply be sprayed into vacuum chambers with the addition of 3 grs. of lime to the gallon, before passing into the pipe. A plant was designed for this purpose on the principle of a barometric condenser.* The addition of ferrous sulphate and some alkali to water, filtering off the hydrate of iron before the water enters the line, has been found quite effective in removing oxygen from a solution. By rendering the water slightly alkaline before passing into the pipes, corrosion may be greatly lessened even though free oxygen is present. In many cases, however, this would interfere with the use of the water for certain purposes.

Doubtless other means will be found to remedy the trouble when the economic importance of the problem is fully realized by engineers. Elaborate plants are provided for treatment of boiler water, which pay for themselves in a few years many times over, but so far in this country we continue to suffer loss in water lines, and, as a rule, the responsibility is shifted onto the pipe manufacturer. Not that pipe cannot be improved, for steel pipe is now made which is much better than that put out ten years ago, and even superior in lasting quality to the much-talked of brands of wrought iron. Protective coatings more suitable for modern conditions are also possible, but we should endeavor to apply the

* *Engineering Record*, May 21, 1910.

obvious remedies and remove the fundamental cause of the trouble.

DISCUSSION.

Mr. Barwick: Mr. Speller is also a member of the same committee of which I am a member. Our committee has not been able to get together, but, following the remarks of Mr. Speller, I will exhibit some samples that I have taken from a building in the City of New York. Before offering the samples I want to state that the building is of iron frame construction, and the illustration will show the action of electric currents passing through, and grounding through the steam pipes. Very little corrosion is on the outside; most of it is on the inside. (The speaker exhibits a sample of iron pipe.) That is a short piece of 1¼ in. pipe, which was running in a trench about 12 x 12 ft. underneath the floor of a basement, that is partly underground; that is, the building is on the slope of a hill. This sample will show the action of corrosion. Now this pipe was part of the return main and was covered with 85 per cent. magnesia, canvas jacketed and banded.

This ¾ in. pipe (the speaker exhibits another piece of pipe) was in the same trench, and was one of the connecting pipes to the radiation, and was also covered with 85 per cent. magnesia.

Here we have the case of a riser dropping down through the floor into a trench. Part of this pipe was exposed above the floor at about the point where you see the worst corrosion. Beside the place where the sample was taken there was a water tank and this pipe dropped down through the floor.

Now the theory is that a stray current of electricity passes through the iron structure of the building into the ground, and some of the current passes through this pipe, and then from that into the ground. The covering undoubtedly was wet and water must have gathered in the gutter so as to form a good connection, and the result you can see in this sample.

Prof. Carpenter: During the year I have had an opportunity to observe the behavior of steel and iron tubes in a water tube boiler, and this paper seems to bear on this particular subject. In this particular instance the boilers were large ones and subjected to heavy steam pressures; and, regardless of the price, I tried to have the very best material in the tubes we could get. The boiler maker recommended that we put in a certain grade

of wrought iron tubes. for which we paid an extra price. We put those tubes in and in a very few months we commenced to have very serious trouble with them. There were three large boilers, each 600 horse-power, and each with a great many tubes.

The character of the trouble was the formation of blisters, principally on the inside of the pipe, which made it necessary to remove the tubes so attacked. In the course of the first year nearly one-third of the tubes in the boilers had to be removed. I immediately discussed with the manufacturers of the boiler all the questions relating to these failures. As a result I had a letter from the president of the company, in which he said he was satisfied that the day of "the wrought iron boiler tube had passed," and some other things of the same character.

In connection with my university work I have tried to get a line on the relative life of steel and iron pipes from the experience of neighbors. About the only evidence we have had has been the experience of the superintendent of our heating system. Now he is certain that a wrought iron pipe lasts much longer than a steel pipe, and he can point out very many cases to support this contention. You see we have two absolutely contradictory experiences.

Mr. Barron: The last remark of Prof. Carpenter strikes me fully as the experience of every steamfitter, practically, in the United States, of every mechanic who deals with piping, of practically every consulting engineer who has to specify piping, and of every manager of a large works who has to buy a great deal of piping. The general experience is that puddled iron costs a great deal more than steel in the first place, but that in the long run it is the cheaper because of its durability.

Now where two pieces of pipe run up through a room as steam and return risers, the return riser being steel and the steam riser being wrought iron, whether one would last longer than the other I am not prepared to voice an opinion. I think they would probably last just as long as the building would last, practically. But where they are put in the earth, the experience, or the general consensus of opinion, is that the wrought iron will outlast the steel.

Mr. James H. Davis: I would like to ask a question regarding the sample that was passed around, that was supposed to be part of a water system. The pitting, as I see it, is all from the in-

side, and being a hot water system it is supposed that the air is practically excluded, which would off-set somewhat the theories that were advanced about corrosion. According to that sample the corrosion takes place whether there is air present or not.

Mr. Speller: All the samples that we have been talking about are taken from hot water supply lines, not heating lines; the pipe is attacked by all the air the original cold water contained. Now we all know that hot water heating lines do not corrode seriously, because by using the same water over and over again the pipe will last indefinitely, since there is only a limited quantity of air and very little opportunity for corrosion to continue.

I would like to ask Prof. Carpenter whether the steamfitter produced any evidence or whether his was the same experience that Mr. Barron has talked about? Many steamfitters have a strong feeling in favor of wrought iron, for it is the material that has been used for three generations in the manufacture of pipe. It is easy to thread, but with a little attention to the dies and lubrication the steel threads just as readily. But when it comes to actual pressure tests and comparative durability under service conditions, mere opinion is most misleading; and the evidence I have to offer points to the fact that in every case of comparative corrosion we know of we do not find any practical difference between iron and steel pipe, quite contrary to the opinions often expressed.

Now the basis of this paper to-day is some twenty cases collected by Prof. Woolson from hot water supply lines in New York City, which showed no difference between iron and steel. I produced twenty more cases, taken from the feed water lines of the Frick Coke Company, in the mining district, and they showed practically the same results; and so we can go almost indefinitely. We intend to continue the investigation until the truth about this matter is established; but just so long as we have an unsupported opinion, just so long we will be in the dark on this question, for few can tell whether the pipe they are looking at is wrought iron or steel.

Prof. Carpenter: The testimony which our superintendent gave regarding this matter was founded on his own experience. He took me around to show me several instances where he had put in steel pipe and where it had given out and he had replaced it with wrought iron; and he also described several cases where he

had put in wrought iron pipe which had remained sound. The result of this experience led to the abandonment of steel pipe. It seems to me that the final settlement of this question must depend very largely on the results based on the careful experience of people using pipes. A short laboratory experiment on the corrosion or the effect of corrosion on metal is very liable to be misleading. I undertook to make some experiments on this subject myself, but I soon became convinced that I could not arrive at conclusive results. The only proper way this question can be decided is by allowing known qualities of pipe to remain under essentially the same conditions for some considerable time.

It is very common in all of our heating systems to find both iron and steel pipe which shows the effect of corrosion under certain conditions. In our heating systems we have trouble, no matter what the kind of pipe.

One condition may have misled our superintendent in his conclusions. A few years ago most of the steel pipe that we bought was light in weight and not of full thickness. Light steel pipe cannot be fairly compared with standard wrought iron pipe. If that condition was not considered his comparison is not on a fair basis.

President Hoffman: I presume, too, Prof. Carpenter, that in the rating of your pipe you would have both chemical and physical tests of the pipe specified very carefully, so that merely a casual observation would not settle the matter as to whether it is wrought iron or steel.

Prof. Carpenter: Yes, if necessary, but there is no question about the class of the pipes in question.

Prof. Kent: I would like to ask Prof. Speller whether there is any information as to the effect of manganese in steel on the corrosion of pipe. In former days manufacturers used to be rather careless about the percentage of manganese, but I understand that in recent times they are getting the manganese lower.

Mr. Speller: The manganese used nowadays is much more uniform than it used to be, and lower, too. But the presence of manganese does not have any effect one way or the other. It is simply a question of having it uniformly distributed, and that is comparatively easy with the means we have at our disposal now. Wrought iron carries less manganese as a rule, but it is much

more variable in other constituents. The manganese may be nothing and it may be 0.2 per cent.

Prof. Kent: Hasn't something been put on the market as a substitute for manganese?

Mr. Speller: Yes, there is open hearth steel in which they use silicon instead of manganese as a deoxidizer; it is not a proposition that we consider safe for pipe as yet.

Mr. Waldron: The Chateau Frontenac, in Quebec, has recently built an addition of reinforced concrete construction, with cinder fill between the concrete and wood floors. In this cinder fill are imbedded lines of extra heavy galvanized iron pipe. The manager of the hotel showed me two pieces of this pipe, one the size of the original and one a piece that had been in for less than two years. The exterior of the piece that had been imbedded in the cinder had been eaten away, not pitted, but actually laminated, to one-half the thickness of the original pipe. You could take a jackknife and peel off scales of rust from ¼ in. to 1 in. in length.

The cinder concrete was made of ashes and cement and a little sand, the usual mixture. After making a few inquiries I found that the hotel had its own electric light plant, direct current. Evidently that pipe had a leak in it at some point or had been placed in the concrete and allowed to dry. The combination of circumstances there had produced this exterior corrosion.

Mr. Barron: I would like Mr. Speller to give us his opinion about the statement made by Prof. Carpenter that possibly the wrought iron pipe was full weight pipe and the steel pipe was light weight pipe.

Mr. Speller: That seems like a very reasonable explanation Prof. Carpenter offers for the results observed. Steel pipes have been and are still made full weight and what they call merchant weight, which is lighter. You can get either. Wrought iron is made by some manufacturers in the same way; and if you want a certain weight of pipe you should be careful to specify it. Now as to the matter of laboratory tests which Prof. Carpenter mentions, I purposely avoided any reference to these, although there are a great many on record. We are now passing through a time when we can get all the service comparisons we want, if we hunt around to find them. I wanted to get your

opinion on this method of investigating the subject, as to whether it was quite satisfactory, because I believe there are plenty of places where, by a little patient hunting, we can find comparisons of iron and steel pipes under identical conditions, so that we will not have to consider laboratory tests any more. All the samples I have shown you and the work I have described to-day are taken from service tests covering anywhere from two to twelve years, according to the severity of conditions, and all are from hot water supply lines, which of course include the essential elements of all corrosion, namely, the combined presence of water and air.

Prof. Carpenter: We have found in our experience that the worst corrosion occurs on pipes used on the returns from steam heating mains. We have the most failures in the returns.

Mr. Franklin: We all know the effect of electrolysis upon pipes. I had a case only a short time ago. I think it was wrought iron pipe, because that is what we are using. It failed in six months, and it had a hole right through it from that effect.

The fact remains that our experience is that we have better results with wrought iron pipe than with steel, and we are using wrought iron pipe for that reason. Most of the men connected with my establishment are young men, and they are not prejudiced one way or the other, but their demand is for wrought iron pipe, because of the experience that they are having right along. If they put in steel pipe they have trouble with it. That backs up my experience for a good many years.

I suppose all know the bad effect cement has upon pipe if it comes in contact with it. The gentleman mentioned the fact, at the Chateau Frontenac, that with cement coming in contact with the pipe there was an action that caused trouble. I had a case twenty-five years ago where I told a builder to be sure to keep cement away from the pipe. "Why," he said, "I have just taken out a steel beam that has been in twenty years and is as bright and clean as when it was put in." I said, "Oh, yes; a steel beam is one thing, but wrought iron pipe underneath the marble floor of this cafe is no comparison whatever. Don't you let any cement come in contact with this pipe." But he was an old builder, he knew it all and couldn't be told anything, and he covered the pipe with cement, and in six months' time the waiters in that cafe were going around with swollen feet because the

marble floor was so hot. We had to take up the floor then and put in brass pipe.

Mr. Boyden: I have noted a great many cases of corrosion of return pipes and also blow-off pipes of boilers, and I would like to ask Mr. Speller if he has conducted any tests on pipes where boiler solvents have been used to eliminate scale. I think that has some bearing on having the return pipes in fair condition.

Mr. Speller: No, I haven't any experience with boiler compounds. We use a plain boiler water treatment that does not involve anything else than lime and soda ash in proper quantities, using settling tanks. We use no compounds at all, and we do not have much trouble with corrosion in Pittsburgh in boilers with treated water.

These matters are subject to scientific treatment and can be remedied if they are gone at in the right way. Of course you will have trouble with the return steam lines where you have water of condensation and air, just as you will in hot water service lines.

Prof. Kent: In regard to boiler compounds, I will say that the soda ash or carbonate of soda, and caustic soda are the two satisfactory boiler compounds, and they can be bought generally at any druggist's, and they are anti-corrosive. They protect and do not corrode. If you buy a boiler compound whose composition you do not know, you are apt to get an acid compound, and then you have bad results.

Mr. Boyden: We find if we use steam from boilers for cooking purposes where they use the open steam, that we have to be careful in the selection of a solvent. Some of the things Prof. Kent mentions will discolor potatoes; kerosene is used in other compounds. That is a disagreeable feature. I have been unable to find a boiler solvent that we could use satisfactorily where there is a great amount of cooking done by open steam.

Mr. Waldron: I would like to correct an impression that has gone forth in regard to the laying of pipes in cement. The question that was brought referred to pipes buried in cinder concrete. Cinder concrete is naturally porous, and I presume there is more or less sulphur in the cinders; its capacity for absorbing moisture is much greater than the ordinary concrete composed of sand and gravel. But, as a general principle, I do not think it would be advisable to imbed pipes subject to expansion and contrac-

tion in a solid mass, because in time the pipe would work itself loose. I do not think there is as much trouble with pipe corrosion when buried in a straight concrete of cement and sand and broken stone as there is in a cinder concrete, which is the fill usually used in a concrete building, between the main floor slabs and the wood floor. Tar concrete is much better for this purpose.

Prof. Kent: In the steel works in Pittsburgh many years ago it was a practice to extend the works on made ground, which was composed chiefly of old cinder piles. There it was the universal custom, when running a pipe through made land, to imbed it in about 1 sq. ft. area of yellow clay, so as to protect it from corrosion due to sulphur in the cinders. I do not think that pipe should be laid in cinder concrete unless it is thoroughly protected from the corrosive action of the cinders.

President Hoffman: We are certainly getting some very good facts. Are there any other remarks?

Mr. F. K. Davis: I do not think the oxygen of the air or water is always the cause of corrosion. I have seen electric conduits taken out of cinder fills and cinder concrete that were as badly corroded as any pipe shown here to-day. Those pipes were originally coated with an asphaltum compound, but they were honeycombed and eaten out, and it is the opinion of many that free acid in cement in addition to sulphur in the cinder is the corroding influence.

Mr. Speller: We intend to keep on with this work, and we would like your co-operation, and I will communicate with the Committee on Corrosion if I hear of any further experiences of this kind. I can only advise that wherever you have trouble with corrosion you look around over your line and see if you cannot find some case of comparison. The fact that you have a piece of steel that has given trouble does not mean that steel pipe is any worse than wrought iron, unless you find a piece of wrought iron with it which is in better condition. We should always remember that it is a fact that whether iron or steel pipe may last a few weeks or a hundred years depends entirely on the conditions in which it is used. Perhaps more will be said about this matter next year.

CCXXXV.

THE VALUE OF GOOD VENTILATION.

BY SEVERANCE BURRAGE, PH.D.
(Non-member of the Society.)

The widespread interest in the campaign against tuberculosis which has grown so rapidly in the last few years has served to publish the fact that one of the most important predisposing factors to tuberculosis and pneumonia is bad air. Foul air is brought about by absence of or faulty ventilation. Another fact, which has been developed during this same campaign, is that not only is the health greatly improved and the power of resistance of the body against disease greatly strengthened by breathing pure air, but much more efficient work is being done by those studying and working in well-ventilated rooms. The plea for good ventilation, then, may be based on two points:

First. *Health*, the prevention of unnecessary sickness and death.

Second. *Economy*, the increase in the efficiency of the occupants.

One of the common excuses for not having systems of ventilation in buildings is that they cost money. But if lives can be saved, sickness prevented, less time taken out on account of sickness and more efficient work done in rooms or buildings where there is good ventilation, the "expense" excuse sounds very weak.

It is surprising how many buildings are not provided with any system of ventilation whatever—buildings in which numbers of individuals come together daily for several hours' continuous work or study. If such buildings are school-houses, the lack of ventilation, therefore bad air, can be looked upon as responsible for many deaths from tuberculosis, the children having been rendered susceptible during their school days, and dying between the ages of twenty and twenty-five—in the

very prime of life. If the buildings are factories, work-shops or stores, much less efficient work will be done by the occupants, much more time will be lost on account of sickness of the employees, and the employees themselves will be rendered susceptible to many germ diseases. Such buildings should be provided with ventilation. It will be economical in the end.

Sometimes there are serious faults in buildings that are provided with ventilation systems. For example, a school building may have provision for a pure air supply that only operates when the heating plant is in operation. Then the rooms are ventilated during the cold months and depend on their natural ventilation through the doors and windows at all other times. I have noticed this fault in many public school buildings. With the present availability of electricity for power to drive fans, there seems to be little excuse for this. Another example: I found a recently completed hospital in one of our large cities with the fresh air intake in close proximity to the outlet of the ventilating shaft from the kitchen and laundry.

Another and very serious fault is the failure to provide ventilation for toilet rooms in school-houses and other buildings in which all the other rooms are ventilated. The very rooms that need to have the bad odors and foul air removed from them are neglected! Newly constructed college and technical school buildings have had this unsanitary condition thrust upon them.

Many buildings are provided with apparatus for supplying pure air, but with no means for regulating the amount of moisture in the air. Consequently, the air is usually too dry. An excellent discussion of the "Effect of Dry Air on Health" may be found in a paper by W. E. Watt, of Chicago, in the *American Journal of Public Hygiene,* June, 1910. In this paper the author proves that the air in many of our school rooms "is drier than that of the driest desert on the face of the earth." He goes on to say that in his school, when the rooms are provided with humidified air, temperature 62 to 64, "we are clear-headed and feel well. When the new air was introduced it cut down the number of cases of office discipline 80 per cent." "Humidified and cooler air saves one-fifth of the coal as well as adding vitality and efficiency."

These faults and defects in our ventilated and unventilated buildings should be remedied to bring about a more healthful condition, as well as to bring about more efficient and more economical operations.

The important impurities in the air of buildings are in the form of gases, odors and dust. In the list of the gases we frequently find carbon dioxide mentioned as the most important. It rarely exists in the air in sufficient quantities to be actually poisonous to our bodies, and I believe that its importance lies only in its being a danger flag, pointing out the possible presence of other and more harmful things.

If the carbon dioxide in a room has come from the combustion of some fuel in which the combustion has not been complete, carbon monoxide may be present, which is poisonous in very small quantities. Escaping illuminating gas may cause its presence in a room or building. If the carbon dioxide has come from the lungs of human beings, it will then indicate the possible presence of germs of disease which will be in the rooms or buildings in the form of dust; not that the germs shall have come from the lungs, but from the bodies and clothing of the individuals. I think too much importance has been attached to the amount of carbon dioxide in rooms. It may serve as a very crude measure of the purity of the air, but I am doubtful as to its value as a standard by which to test the efficiency of a system of ventilation. Rooms in which the carbon dioxide has been shown to be less than the maximum permitted by authorities have in some cases given rise to headaches and drowsiness.

I believe that an examination into the purity of the air in buildings, where a ventilating system has been or is going to be installed, should involve much more than a simple and rather doubtful test for carbon dioxide. The humidity, the amount of dust, the number of people, the character of the employment of the occupants, the number of continuous hours occupied, the climate, the height and shapes of the rooms, the nature of the outside air, the method and times of dusting and sweeping, all these and many other factors must be taken into account, and the system then installed which will give the best results. It seems to me to be just as unreasonable to lay down rules or standards for ventilation systems as it is for the

water works engineer to say that one method or standard of water purification must be applied to all cases. Each city has its own peculiar conditions, its own problems of water purification to solve. Just so, I believe, each building, and each room in a building has its own problems of ventilation to solve. There should be closer connection between the work of the architect and that of the heating and ventilating engineer. More careful work will bring about more healthful and more economical conditions.

(*For discussion, see Paper CCXXXVI.*)

CCXXXVI.

STANDARDS OF VENTILATION.

BY W. A. EVANS, M.D.
(Non-member of the Society, presented by request.)

The harm that is done by bad air falls into two groupings. The first is the air borne infections, such as colds, bronchitis, pneumonia, consumption, anterior poliomyelitis, and cerebro spinal meningitis, and, in small measure, smallpox, diphtheria, measles and scarlet fever. In this group the harm which is done shows itself rather promptly. We speak of this group as quick-acting. The second group is that of air caused conditions. They are the slow-acting intoxications causing sleepiness, drowsiness, mental hebetude, anemia, headaches, flabbiness and increased susceptibility to infections.

It has been found impossible to apply the ordinary principles of etiology to carrier mediums. For example, it is accepted that typhoid fever is milk-borne, yet no one has isolated the typhoid bacillus in any milk which was causing typhoid fever. This is true of water and air. Therefore we cannot be more specific than to say that air which has a general bacterial content over a certain figure is presumptively harmful. The same principle applies with regard to the second group.

The harmful constituents or qualities of expired air are not understood. For that matter, we cannot say just what is harmful in any other excrement. Analyses and experiments with feces have never made it possible to say just what element therein causes harm; no one has ever isolated the toxic substance in urine; but it can be assumed that they are objectionable æsthetically and from the health standpoint. These things are true of expired air.

Therefore with air there can be no single standard of efficiency of ventilation in the present state of our medical and bacteriological information. The standard must be a complex composed of standards on different qualities of air and different methods

of procedure in handling the air. Some of these can be quite definitely stated; some are still so vague as to be suggestive only.

As to ventilation, is not the standard the complex standard of everything in hygiene and sanitation? For example: If a building is so located that it gets lots of sunshine in its interior, the ventilation standards can be lowered twenty per cent. with safety to the occupants. If the ventilation is of a basement where sunshine cannot get in, then the standard should go twenty per cent. over the normal or, in a hospital, the standards must be higher than elsewhere, because the general health rate is lower; or, if people bearing potential infection are jammed very close together the standard must be higher than where occupation is very sparse; or, if hygiene and cleanliness are of a very high standard the ventilation standard can be lowered.

The standard complex theoretically should be "such that no inhabitant should be harmed immediately or ultimately by the air of the place ventilated." In order that this may be brought about it is necessary that every factor be standardized. To standardize one and leave the others untouched may or may not accomplish the result according to the laws of chance. This, however, is not scientific. A standard of ventilation must consist of many standards.

1. *Dust Content.*—A series of dust standards should be adopted. These standards should vary according to the harmfulness of the dust. Where the nature of the business makes organic dust, e. g., milling, the amount of dust allowed should be high. Where the business produces inorganic, inodorous dust it should be low, e. g., metal polishing. It should be intermediate where the dust is odorous, e. g., painting. It should also take into consideration human contamination of the dust, e. g., carpet cleaning, janitor service.

If the dust is made on the premises a higher percentage is allowable. If the dust is inorganic it is more harmful than if it is organic.

All of these factors must be taken into consideration in determining a standard. I am not sufficiently informed to suggest such standards as to quantity.

2. *Humidity.*—There should be humidity standards. Air which is too wet or too dry is unhealthy and uncomfortable. If it is too dry it desiccates mucous membranes; hence it determines

infections. If it is too moist its conductivity is too high and it determines infections. To hold the humidity fairly uniform permits of comfort under wider ranges of temperature. It permits of more air currents.

Suggested standard: 60 to 80 relative humidity, or 10 to 20 degrees maximum difference between inside and outside humidity. The method of determination is by the wet and dry bulb thermometer.

3. *Temperature.*—Probably a temperature standard is the most imperative of all. It is also the most easily inspected and judged.

Whenever the temperature of the air of a room mounts higher than 70 degrees the air of the aerial envelope of the human body and the air of the breathing zone has practically no tendency to displace itself. It is therefore both unhealthy and uncomfortable. If fresh air can be blown against the body or into the breathing zone with sufficient force to displace the air of these locations, higher temperatures are harmless. In other words, the body purges itself of the harmful contents of exhalation and expiration by heating the air in which they are discharged. This as a force is ample so long as the environment is say, 65 to 68, and below. If the temperature of the environment passes this point harm results, unless currents of the same or greater power are substituted therefor.

Suggested standards where the air is free from appreciable currents: The temperature should not rise above 65 degrees Fahr. When the air currents are moderate the temperature should range from 68 degrees to 70 degrees Fahr. When the temperature passes 70 degrees Fahr. the air currents should be travelling not less than ten miles an hour when they strike the body and the head zone.

Methods of gauging: Thermometers properly placed with regard to heating, lighting, occupation, radiation, convection and conduction.

4. *Carbon Dioxide.*—In establishing a standard for carbon dioxide it is well to bear in mind certain fundamental facts:

(a) The carbon dioxide produced in the human body is a harmful agent, but it is not violently so, or immediately so; neither is it the most harmful agent or quality of expired air.

(b) It is a good index of pollution when animal life is prac-

tically the only agency of production operating in the area which is being judged.

(c) While the CO_2 produced in processes of manufacture is slightly harmful, air containing a given content of CO_2 is much less harmful than air containing the same proportion of CO_2 to animal expirations.

(d) CO_2 is a readily diffusible gas and therefore in a given room the proportion of CO_2 is the same at all points, regardless of temperature conditions and location of agencies of production. Diffusion requires a little time, therefore, in a room with uprising air there is a slight excess at the ceiling, there is a slight excess at air outlets regardless of whether they are located at the floor or the ceiling. As it is impossible to keep all the air around lights, etc., from rising, there is always a very slight ceiling excess even in downward ventilation installations

Therefore—the amount of CO_2 in a room should not pass ten parts per 10,000, if it is all being produced by animals. If it is being produced by other agencies it can pass this figure. It should be regulated for each industry. For example, in the brewing industry the CO_2 will probably be unassociated with any other harmful substance, therefore it could safely be allowed to pass 30.

In brick burning it would probably be associated with considerable SO_2, therefore 15 would not be compatible with comfort.

Methods: The Rogers modification of the Peterson-Palmquist apparatus is the best thing we have.

There is great need for some simple approximate test.

5. *Odors.*—It is impossible to standardize odors. The personal equation is so large a factor that no certain rules can be applied. Generally speaking, odors do good rather than harm. In order to be rid of them ventilation becomes masterful; under practically every other circumstance it is suggestive. Under ordinary circumstances we think the air should go in a certain direction, and we persuade it to go there more or less mildly. When there are odors we force it to go where it should go. In that odors make for ventilation they do good. The aromatic substances which we ordinarily encounter are not at all toxic immediately or remotely in the doses in which they are contained in the air. If, on the other hand, for example, the odor

of the stock yards is objected to by a woman, and if she tries to lessen them by putting down the windows, she will get bad ventilation in her home and thus be indirectly harmed.

Another indirect effect of odors is this: Cooking odors are not at all harmful. They are not objectionable to some people at any time. To other people they are welcome at some times and objectionable at others. Nevertheless a hotel which allowed its kitchen odors to get into its bedrooms would be avoided by the travelling public. Again, the cooking odors which come from the stock yards are not harmful, yet a man renting or buying a house, and being under no compulsion to rent or buy in an odorous neighborhood would not do so. From the standpoint of odors, there is but one thing to do, and that is, to make the premises as nearly neutral as possible. Beyond this no standardizing is possible.

The removal of odors is easy where the odoriferous air is warm. For example, in a kitchen. Here the method is direct and immediate upward removal, so placed that cross currents are reduced to a minimum. On the other hand the odor of ice boxes is removed by direct downward flow of air. If the temperature does not aid, as, for example, in a shoe establishment, a paper establishment, a small ice box installation, a reading room in a library or other place with many body odors, about the only available method is periodic blowing out by wind through open windows, or compressed air or vacuum. There is no satisfactory method of determining odor pollution except in special cases; for example, ammonia.

6. *Feel.* There is no way of standardizing the feel of air. The personal equation here is quite as large as it is in the case of odors. The feel of a draft which would be highly agreeable and stimulating to one man would cause the next grave dissatisfaction. And yet there must be a something in the feel which cannot be analyzed. It is a sense which should be of great value if we could develop a set of "feelers" who would be the judge and jury. What makes it impossible is the individualism of the feelings. There is a very definite something in the better feel of a sunned and aired bed or the atmosphere which irritates enough to stimulate but not enough to be unpleasant. It is a great pity that such individualism as that displayed by the draft crank makes the feel an unavailable factor in ventilation.

In the present state of public intelligence on ventilation, the engineer who invites and stimulates criticism on the basis of the feel is making insurmountable trouble for himself. There is no instrument or apparatus to measure the feel of ventilation.

7. *Volume of Air.*—There is need for a standard of volume of air per inhabitant, as a part of a composite standard. As the only standard, it has probably been the basis of more so-called ventilation than any other item. Ventilation based on volume alone has not made good, could not be expected to make good. In considering volume, variation in the standard is required. As the British Parliamentary Commission have well said, "It is not so much the volume of air which you put in as where and how you put it in." Four cubic feet of air will contain enough oxygen to supply a man's needs for one hour. However, it is impossible to extract all of the oxygen from the air. This would then represent the ultimate theoretical possibility. Seventeen cubic feet of air will furnish enough extractable oxygen for a man for one hour. Let us call this the theoretical possibility. It would supply all that was needed by a calm, cool, idle man if the foul or exhalation air high in CO_2 and in moisture was kept entirely away from the inspired air.

In a given installation the quantity of air needed is in inverse proportion to the separation of these two airs. If we can arrange our inlets and outlets right, and hold our window and wall chill to a minimum, 400 cubic feet per person per hour would not be far wrong. If we promote mingling of the good and bad air, 2,000 cubic feet per hour is required. If we make no provision for removal, and have none except through leakage, 10,000 or more cubic feet is required.

Therefore we can have a standard varying from, say 20 cubic feet per inhabitant per hour up to 10,000, in proportion as we are able to maintain the head and body of the occupant in a current moving steadily in one direction. The 20 end of the scale is always unattainable. We ought to be able to maintain enough freedom from cross currents to make from 500 to 1,000 proper. Where we try to bring about development of cross currents, I have never seen 2,000 suffice.

Therefore I should say in installations where there is intelligent effort to move the air uniformly in one direction, 400 to 1,000 cubic feet per hour per inhabitant would be sufficient; where dif-

of the stock yards is objected to by a woman, and if she tries to lessen them by putting down the windows, she will get bad ventilation in her home and thus be indirectly harmed.

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Therefore we can have a standard varying from, say 20 cubic feet per inhabitant per hour up to 10,000, in proportion as we are able to maintain the head and body of the occupant in a current moving steadily in one direction. The 20 end of the scale is always unattainable. We ought to be able to maintain enough freedom from cross currents to make from 500 to 1,000 proper. Where we try to bring about development of cross currents, I have never seen 2,000 suffice.

Therefore I should say in installations where there is intelligent effort to move the air uniformly in one direction, 400 to 1,000 cubic feet per hour per inhabitant would be sufficient; where dif-

fusion is the principle employed, 2,000 to 3,000 cubic feet per hour; where leakage is employed, say 5,000 to 10,000 cubic feet per hour.

Method: There is not much difference between the wheel and the pressure anemometer. Each is moderately accurate.

8. *Cubic Feet of Space.*—A proper standard of ventilation must take into account the cubic feet of space per inhabitant. But this also must be with a proper regard for the other standards. If it is taken as a sole standard it will oftentimes serve to entrench bad ventilation conditions. For example, such a condition prevails in the present factory law of Illinois. Badly ventilated factories which conform to this law are in a better legal position than they were under general police powers.

This standard is of considerable moment in standards of volume of air furnished. If there is a large cubic content of air per inhabitant, there must be an increase in the volume of air per hour per inhabitant. In figuring cubic content of air, it is necessary to know how much of the product is due to height and how much is due to length and breadth. If the height of a ceiling is 20 feet, obviously the upper 10 feet of air does not give the same factor of utility as that of the lower 10 feet. The maximum utility comes from the air which is below a point, say, two to four feet above the breathing zone. There should be one standard for rooms with 10 foot ceilings and another for higher ceilings, say 10, 20, 30, etc. And, finally, nearly everything depends upon the volume of air furnished. In a street car which is packed to the last floor inch with people, there is about 10 cubic feet of air space per passenger not displaced by the bodies of the passengers or by the seats and other furniture. This is, of course, an impossible condition of affairs if air is not properly furnished. It is not a markedly deleterious condition in a summer type of car, and it may be made passable by furnishing air flowing at the proper rate and in a uniform direction. In fact, a small cubic feet of space with control of the volume and direction of air represents the maximum economy of use of ventilating air compatible with efficiency.

One thousand cubic feet of air per inhabitant is the usual standard for a 10-foot ceiling. It should be raised for a higher ceiling. It can be lowered for a lower ceiling. It can also be lowered when there is a guaranteed ventilation efficiency.

9. *Air Currents.*—Next to temperature and humidity that which adds most to the discomfort of a room is currents or lack of them. The morgue-like stillness of certain places means that there is no force to change the air of the aerial envelope or of the breathing zone except the difference in temperature between the expired air and the surrounding air, and when the room temperature passes 70 degrees Fahr. this force is very slight. On the other hand, the thing which people probably complain of most frequently is a draft.

Ventilation standards will be materially improved if they establish:

First. Unoccupied zones around inlets and outlets.

Second. Temperature of incoming air graded according to occupation of inhabitants.

Third. Rapidity of flow of incoming air.

Fourth. Efforts to control, not to prevent, currents, within the room.

I have no standards to suggest.

10. *Bacterial Standard.*—A bacterial standard for air is just as desirable as is a bacterial standard for water or for milk. Beyond this suggestion I do not care to go at this time.

DISCUSSION OF THE PAPERS OF DR. BURRAGE AND DR. EVANS.

Prof. Kent: In regard to Dr. Burrage's paper on "The Value of Good Ventilation," I think the most of the paper will be considered to be an expression of the fundamental facts we are all agreed on, and they have been said before over and over again. But we find a statistical fact, quoting Dr. Watt, of Chicago, "When the rooms are provided with humidified air, temperature 62 to 64, we are clear-headed and feel well. When the new air was introduced it cut down the number of cases of office discipline 80 per cent." And the quotation goes on to say, "Humidified and cooler air saves one-fifth of the coal as well as adding vitality and efficiency."

That is important, if true, and I think that it should be brought prominently to the attention of heating and ventilating engineers and school authorities and others, to see if they can make experiments in schools to find out whether it is true generally or only in this particular case. We are always glad to get facts

of this kind. The statement that humidified and cooler air saves one-fifth of the coal, however, seems to be far from true. I have made a calculation, which indicates that the evaporation of the moisture required for humidifying actually requires more fuel than is saved by heating the air to a lower temperature. Suppose the outdoor air is at 32° F. and 80 per cent. relative humidity. How much heat will be required to raise the temperature of 1 lb. of air to 72° without humidifying it; and how much will be required to heat it to 62° and to evaporate enough water at 62° to make its relative humidity 50 per cent. The following data for the calculation are taken from standard tables:

Temperature.	Vapor in 1 lb. of Air. Saturated.	Humid.
32°	0.003744 lb.	0.002995—80% humidity.
62°	0.011709 "	0.005855—50% "
72°	0.016691 "	....
	Difference,	0.002860

Specific heat of air	0.2375.	Heating 1 lb. from 62° to 72°,	2.375 B.t.u.
" " " vapor	0.48	" .002995 lb. " " " "	0.014 "
			2.389
Latent heat of vapor at 62° F. 1057 B.t.u.			
Evaporating 0.00286 lb. water at 62°, × 1057 =			3.023
		Difference 26.9% of 2.389	0.634

That is, it takes 26.9 per cent. more heat to do the humidifying at 62° F. than it takes to heat the air from 62° to 72° without humidifying. To heat the 1 lb. air from 32° to 72° without humidifying requires

$$4 \times 2.389 = 9.556 \text{ B.t.u.}$$

To do the humidifying and heating only to 62° requires 0.634 B.t.u., or 6.6 per cent. additional. That is, instead of humidified and cooler air saving one-fifth of the fuel, it actually requires 6.6 per cent. more fuel.

Dr. Burrage says also: "I think too much importance has been attached to the amount of carbon dioxide in rooms. It may serve as a very crude measure of the purity of the air, but I am doubtful as to its value as a standard by which to test the efficiency of a system of ventilation."

We are all doubtful as to its value as a standard, but unfortunately we have no better one to-day. We have to take the CO_2 standard until the doctors and scientists and physiologists have furnished us with some other. Too much importance cannot be given to this CO_2 standard until we can get a better; then it may be regarded as of secondary importance.

In the last paragraph he seems to talk against standards of ventilation, for he says: "It seems to me to be just as unreasonable to lay down rules or standards for ventilation systems as it is for the water works engineers to say that one method or standard of water purification must be applied to all cases." That is apparently opposite to the views of the paper of Dr. Evans, which is in favor of standards.

Now Dr. Evans has given us an interesting paper, showing how much general ignorance there is on the subject, and he might have labeled his paper "Some things we do not know about ventilation." Confession of ignorance is the beginning of wisdom, but, while most of us are ready to confess our ignorance of standards of ventilation, there may be a long term of years between the confession of ignorance and the actual beginning of useful knowledge.

The paper generally is a statement of opinion, but it does not appear that the author anywhere gives basis for his opinion. What experimental data have we upon which we can affirm that with sunshine we can put the ventilation standard lower or that the ventilation in a basement where sunshine cannot get in should go 20 per cent. over the normal? Why not 40 or 50 per cent.? Is there any experimental basis anywhere for that figure of 20 per cent.?

Should not humidity differ with the temperature, and what experimental facts have we in regard to humidity except those that are suggested in the paper of Dr. Burrage?

In the schools of New York City the air is not humidified. I believe the general standard of health in New York City is pretty good, and we have temperatures running sometimes down to zero out of doors, at which practically all the moisture is taken out of the air. We certainly have air in the schools of New York of the dryness of the Sahara Desert, but we have no statistics to prove that sickness results from it. And cannot the discomfort and suffering that is said to come from the lack of humidity in the atmosphere be overcome by taking a drink of water?

Has the author really made the experiments to prove the direction of air currents from the body? What basis have we for saying that the CO_2 should not exceed ten parts per ten thousand? Why not eight or twelve or some other figure? I do

not think we have any authority as to the figure except that it has not been questioned for the last forty years by people who have written on it, and there have been some experiments, perhaps, to show that when there are ten parts per ten thousand in a room people are fairly comfortable; and that is about as far as we have gone in any research in the matter.

In all our ventilation systems that are now installed for schools it is customary to specify that we shall supply 1,800 cubic feet per scholar. Why? Because in the judgment of the Boards of Health thirty years ago that was about right, and it got into the Massachusetts law, and it was very easy to follow the Massachusetts law and say 1,800 feet was right. I do not think we have any basis for saying it is either right or wrong. Some other figure might be better. And here we have it announced: "If we can arrange our inlets and outlets right, and hold our window and wall chill to a minimum, 400 cubic feet per person per hour would not be far wrong." Have we any experiments where 400 feet per hour per person was given in a crowded building and found to be right? "If we promote mingling of the good and bad air, 2,000 cubic feet per hour is required. If we make no provision for removal and have none except through leakage, 10,000 or more cubic feet is required." Now where did he get that figure 10,000? How do we get air in unless it gets out? Has any one ever been able to maintain enough freedom from cross-currents to make 500 to 1,000 proper? If it has been done, what facts have we upon which to conclude that 500 or 1,000 or 1,500 is proper. How did the author measure the extent of what suffices?

Now as to the standard cubic feet of space; in one part of the paper Dr. Evans says that CO_2 is readily diffusible, goes to all parts of the room, regardless of temperature conditions; and yet he says that we have to vary our standards according to the height of the room. "If there is a large cubic content of air per inhabitant, there must be an increase in the volume of air per hour per inhabitant." Why so, if it is all equally diffused? "In figuring cubic content of air it is necessary to know how much of the product is due to height and how much is due to length and breadth. If the height of a ceiling is twenty feet, obviously the upper ten feet of air does not give the same factor of utility as that of the lower ten feet?" Why not, if it is dif-

fused? "There should be one standard for rooms with ten foot ceilings and another for rooms with higher ceilings, say ten, twenty, thirty, etc." Has anybody made any experiments to show what different amount of air per inhabitant should be put in when the ceiling is ten, twenty or thirty feet high? What experiments have been made to prove that 1,000 cubic feet of air per inhabitant is the usual standard for a ten foot ceiling, that it should be raised for a higher ceiling, that it can be lowered for a lower ceiling, and that it can also be lowered when there is a guaranteed ventilation efficiency?

Now in summarizing all this, I would say that the amount of our ignorance on the subject is very great. It may be well to make a confession of total ignorance of this whole subject as to the amount of ventilation needed under different conditions. I would suggest that with the immense amount of money that the Government is spending to-day on the Geological Survey, on the Agricultural Department, on the Bureau of Food, and other things, one of the most important researches that might be undertaken is to find out what the standards of ventilation should be.

I would suggest this method of tests: in a school where you have control of the ventilation, where you put in 1,000, 2,000 or 3,000 cubic feet of air per minute, as desired, put fifty children in a room at nine o'clock in the morning and keep them there till twelve o'clock, and put in scientific instruments and measure not only the temperature and humidity, cross currents and sunshine, and barometric pressure, but the effect of all variable conditions on the children; and measure their reaction time, the character of the respiration and of the pulse, and try all the electrical and other devices that may be had in a psychiatric ward of certain hospitals to determine the human conditions. Put these children in a room at nine o'clock and have some very rapid tests lasting fifteen seconds each, say, for the psychiatric record, and get the condition of all those children within ten or twelve minutes after coming in, and then take their condition ten or twenty minutes before twelve o'clock, and find similarly what their conditions are under 1,000, 2,000 and 3,000 cubic feet of air per child; repeat the tests in different rooms, on different days, with different temperature and humidity. I think the physicians and scientific men have gone so far into the study of human conditions that they are able to provide instruments to register the children's

health and nervous condition and strength and fatigue. I think they can tell by instrumental observation when a child has fatigued himself, either mentally or physically.

By investigations of that kind we may be able to find out whether 1,000 or 2,000 or 3,000 cubic feet of air is right, whether 62 or 70 deg. is the right temperature, whether 60 or 80 or some other is the right percentage for relative humidity.

In the meantime, until we have the facts derived from such a research, we can do no better than to follow the standard laid down in the laws of several States, that is, 1,800 cubic feet per hour per capita. We will do very well as heating and ventilating engineers if we see that every school has 1,800 cubic feet. In the future we may have more scientific standards, but they must be based on experiments and not on mere opinions.

Mr. Lewis: I know Dr. Evans and I know something of his work. I think there is no question but that the Doctor is twenty-five or thirty years ahead of the times. He does not attempt to prove with absolute finality these opinions which he offers. But in my opinion there is no question but that he has made or studied more tests of ventilation and air diffusion and the effects of air conditions on people in all sorts of places than all the rest of us put together. He has had three or four chemists working for years in different buildings in Chicago, in street cars, in schools, in theatres and churches, with different methods of ventilation, and he knows a good deal of what he is talking about in these matters.

Mr. Bolton: Mr. President and fellow members: We should not discourage so valuable a contribution as this on the part of Dr. Evans. As one of the Committee on Papers I was impressed with it. The author is a man of standing in his profession, who has reached the conclusion that he, and a great many others of his profession, as well as of our own, have little knowledge upon this particular subject. He states the facts plainly before a body of technical men such as ourselves, with a view to drawing out such a discussion as that which is going on; to which extent he has rendered us a favor, and has done good service to the community.

I agree that this subject is one of such importance that the Government should become interested in it, and I am certain that our Society can do a great public work for the future by making

that its purpose, and endeavoring to get the great resources of the Government or of the Carnegie Institute or similar institutions enlisted in this investigation, which concerns the health of all classes of people and in every part of this country. It is a deplorable fact that to-day a large majority of our fellow creatures live under unhealthy and unventilated conditions, which are not such as we should hope or expect to see prevalent at this advanced stage of the world's progress.

The particular form of occupation of buildings which has interested me for years past has been the tenancy of office buildings. We are proud, in this city particularly, of what we are pleased to call our skyscrapers. We think they represent the highest form of the art of building. But they are absolutely destitute of proper methods of ventilation for their occupants, although for the spaces occupied the highest rates of rentals are paid. There are tenants of offices to-day who pay more than three dollars per annum for every square foot they occupy on a floor which has no means of ventilation at all except the cracks in the window, and even those are threatened by the invention in which our friend Mr. Whitten is so much interested.

I regret to say that I live during my working hours in one of the highest class of offices, for which I also pay a high rental, which is as deplorably lacking in ventilation as any other, and I am ashamed when a client comes in to talk ventilation, because my own system is merely a leaky window and the suction effect of the elevator shafts in the building. I firmly believe I would be asphyxiated if these features did not exist.

In the course of study of elevator service I was led to examine the amount of space occupied by people in business buildings. We know something about the amount per occupant in schools, because these are planned for occupation by a certain number of children. But how many people occupy a dry goods store or a business building at any one time? I found in certain offices in New York City a density of occupancy per thousand square feet that is within fairly well defined lines. Where the highest rentals were paid, and where the greatest crowding occurred is in office buildings in the center of the financial districts, where about 100 sq. ft. of floor area was occupied per person; and when less than that amount is afforded the occupants became unduly crowded, complaints arise of bad air and ventilation, and

tenants move into other buildings where they are not so much crowded, or rent more space for the same number of employees.

Now that is a very curious indication of the fact that people will go just so far toward asphyxiating themselves, and then they will pay more money to stave off the proceeding.

The amount of floor area occupied by tenants varies, away from the center of the financial district, in less crowded districts, in the proportion of from 140 sq. ft. per tenant to 150 sq. ft. per occupant. I followed these observations with others in other cities, and have made observations and secured censuses of the actual number of people occupying such buildings throughout the country—in Chicago, Cleveland, Detroit, Portland (Oregon), Kansas City, Atlanta and Boston—and I find that the occupancy of office buildings generally ranges between 1 person to 140 sq. ft. to 1 person to 200 sq. ft. of floor area.

Such information affords fairly defined lines on which to decide the amount of ventilation to be supplied. In providing for this very important matter of standards of ventilation the first step is to find out by observations, which can easily be conducted by correspondence, how many people are to be crowded into a certain space in different types of buildings.

It is a very deplorable and unfortunate result, of all the good work that has been done in the line of ventilation, that in many of these installations, admirable as they are, you will find that ignorance and lack of practical care has put them out of use. I went recently, for the first time in my life, to visit a prison, one of our leading institutions, provided with a modern and elaborate system of air supply and exhaust, with forced draft blowers and tempering coils. But not one fan in that entire building was operating, nor had it been operated for twelve months prior to my visit. That is what happens sometimes when we have tried to do something good in the way of ventilation, so that we must also educate the people who have the running of such apparatus. How is it going to benefit the unfortunate prisoners in such an institution to know that there is a fine ventilating plant which cost $75,000, unless it is operated? I can assure you that the air in the entire institution was so foul that, as was said by one of the inspectors, you could have cut it with a blunt knife.

Mr. Whitten: If it is pertinent I would like to suggest that we hear from Dr. Gulick.

President Hoffman: We have with us Dr. Luther H. Gulick, of the Russell Sage Foundation, who has charge of school hygiene. We are very much pleased to have him with us, and I know that he has something very valuable for us. I am pleased to have the opportunity to ask him to come up here and speak to you.

Dr. Gulick: Mr. President and gentlemen: I appreciate greatly this opportunity of presenting to you evidences that standards of a physiological character do exist.

The researches of Atwater, Ercklenz, Thompson and others with relation to respiration have pretty nearly overturned the theories upon which present-day heating and ventilating is based. For example, when director of physical training of the public schools of New York City, I was told that the ventilating systems did not ventilate; that the thousands and millions of dollars which we were spending in our wonderful new schools, and which purported to deliver to each scholar 1,800 cubic feet of air per pupil per hour, did not do it. I have investigated in many of the class rooms, under many conditions, under conditions where the wind blew towards the room, under conditions where the wind blew away from the room and sideways, under conditions where the temperature in the room was greatly variant from the temperature outside of the rooms, and, Mr. Chairman, I failed to find a single room in which the ventilating device did not do what it was calculated to do. Nevertheless, though the ventilation in those rooms should have been ample, it was inadequate because based on faulty standards.

The following is merely an illustration. A secretary of mine was obliged to work in an office which was about 8 x 10 x 10. It had a door, but no window and no means of ventilation whatever, not even a transom over the door. For certain reasons it did not seem feasible to transfer her to another room. She was a woman of exceptional vigor and vitality. In the course of two or three months she commenced to show those signs which we ordinarily associate with ill-ventilation—pain in the back of the head, regularly coming on afternoons, inability to think readily, confusion, pain over the eyebrows, general perspiration not related to the heat of the room. I placed an electrically actuated fan in that room which completely and permanently relieved all symptoms of ill ventilation.

This would not be significant as a single case were it not supported by extensive investigations, and there are ample reports on these subjects. In the "Zeitschrift fur Hygiene und Infections Krankheiten," Volume 49, 1905, are articles by Flugge, Heyman, Paul, and Ercklenz which give results of fundamental importance. I can but refer to these.

A man is kept in a hermetically sealed box about a meter square and two meters long. After a time he commences to show the ill effects of staying in that box, has headache, commences to perspire, thinks in a dull confused way—all the symptoms, the classic symptoms of ill ventilation. A button is pressed and a fan started in the box. This removes all symptoms for a considerable period. The same result occurs not in one case, but in case after case.

These careful Germans said: "We will go further. We will put the man in the box and connect his mouth and nose with tubes going outside of the box where there is fresh air." Under these conditions, although not quite so soon, the man showed the same symptoms of ill-ventilation which he showed when he was breathing the air in the box, although he is now breathing outside air.

In other experiments the conditions are reversed. They take the man out of the box, connect a tube with the box and make him breathe into the box. Under these conditions he does not show the effects of ill-ventilation for a long time. He does ultimately, but not quickly as he showed them when he himself was in the box. These experiments are performed on men and on women, on sick people and on well people, on fat people and on thin people.

The University of Minnesota has conducted a series of classic experiments in which cattle are kept in tight stalls. Water is admitted by faucet, food is introduced by a tube, and the room is, so far as possible, hermetically sealed. It is true that a man does open a little door wide enough to slip in and clean the stall and make records such as those of Professor Kent. For thirty-seven days, in the particular experiment of which I speak, a bull lived healthily and happily and gained an average of a pound a day. He accidentally injured one of his horns. We physicians say that vitality is reduced by bad air, and that sores heal with difficulty except under conditions of fresh air. That horn healed

perfectly, and just as rapidly as did that of a bull whose horn was purposely injured at the same time outside in the pasture. These are matters of official record.

Experiments teaching the same truth have been carried on by Dr. Leonard Hill, of the London County Hospital, by Wesleyan University and by the Carnegie Laboratories under Dr. Benedict. All of these experiments are officially recorded, and the original records are available.

The exact percentage of oxygen in air is not nearly as important as we physicians have thought. There is a neural apparatus in the back part of the brain which controls respiration so that even within such degrees of variation as occur in the worst or the best ventilated room, the amount of oxygen used by the individual does not vary at all. That is if there is 16 per cent. of oxygen in the air the lungs extract from it just as much oxygen as if there were 21 per cent., which is normal. If it falls below 15 per cent. this regulating apparatus which controls respiration is not adequate to overcome the deficiency.

Carbon dioxide normally is present in the air, 0.04 of 1 per cent. This may be increased up to 2 per cent. without affecting the feeling of the individual and without altering his mental processes, provided the temperature is not elevated and provided the humidity is retained at its normal point. That is, this respiratory regulating mechanism of the body is a pretty efficient machine, and so far as oxygen and carbon dioxide are concerned it will take care perfectly of all such variations in the quantity of these two gases as occur even in crowded rooms, of course not in rooms crowded as was the Black Hole of Calcutta, but in such rooms as this, where I do not think there is any ventilation. There may be. Yes, I think there is. But if there is, it is the first occasion in which, through my entire experience as a physician and as a lecturer, it has ever occurred that a lecture on hygiene has been given in a room in which there was ventilation.

Now what I have been saying does not indicate in the remotest degree that ventilation is not important. But it indicates that we physicians have nebulous training with reference to the nature of the standards and the nature of the evils which relate to bad ventilation. When we remember that tuberculosis is now being stamped from out of the civilized world—that disease

which has been responsible for the death of one-tenth, approximately, of all of our kind—and that one of the major means in curing and preventing this disease is the use of fresh air, we cannot for a moment think that fresh air is less important than we have thought it.

But we must consider the other elements which may be connected with the results. Odor has been referred to to-day and is constantly referred to as a reliable, although rough means, by which we judge of the goodness or badness of the air. Now the odor in the air, under any ordinary conditions, comes from decayed teeth, from diseased tonsils and adenoids, from the eating of food which is odorous, from flatulence and from skin which lacks cleanliness. I presume that all of you have visited the crowded school rooms of the lower East Side of New York City and have encountered that characteristic, although not easily defined odor. Now you would say, "Oh, that is dreadfully ill ventilation. What we need to do is to pour into this room a great abundance of fresh air." With the knowledge which we have at present we should say, "The thing to do is to wash the children and see that their teeth are kept sound and that they do not have pus in their tonsils and that in other ways they do not pollute the air of the room."

Our feelings are predominantly related to so-called "mass sensation." This comes not mainly from the organs, not from the bones and muscles, but from the skin. The great mass of sensation results from the stimuli impinging on the outer wall upon our personalities. When the blood vessels of the skin are dilated, and the skin is flushed with blood, the air enmeshed in the underwear, kept close to the body, becomes damp and hot. What is significant here is not the temperature that is in the room; it is the temperature that obtains around the skin of the body. Thus bad mass sensation may come from body heat.

There are now twenty cities in America that have open-air schools where they put children that are pretuberculous. Under these conditions the children increase in the number of their red blood corpuscles and in weight faster than do children from the classes from which they have been taken. On the average they also make better advance in their studies than do the children in

the rooms from which they came. The skin and brain cannot both be flushed with blood at the same time, so that in a room in which the air is stationary there accumulates about the body in the clothing a layer of damp, warm, even hot air. In the endeavor to meet this situation the skin starts up a gentle perspiration. The blood is sent in an unusual quantity flushing the skin. This is one of the great reasons for restlessness. It is not because the children are overworked mentally, but because the material conditions are such as to demand the mass of blood circulating in the peripheral parts of the body. Open all the windows in such a room, or, better still, open all the windows of the building at one and the same time and lower the temperature of that room as much as possible for five minutes. During these five minutes have the children walk or dance so that they will not catch cold. Under these conditions the layer of damp, hot air has been swept away from the body and a colder air has taken its place. This cold drives the blood from the surface, thus again putting the individual in condition to think quietly.

These experiments show that there are other factors in ventilation that are just as important as is the purity of the air, and that wholesome, fresh air is not to be secured by the brainless administration of a ventilating system, and is not merely a matter of so many thousand feet per person per hour of pure air put into circulation.

We are changeable temperature creatures. We need a stimulus of cold occasionally. We need air in motion and variable in temperature. We cannot live at our best at a uniform temperature all the day or all the year. To keep the air about the body and the clothing fresh is as important as it is to keep the air that enters the room pure. There is no best temperature. We all need changes of temperature. Hot air without having a reasonable degree of relative moisture makes us dry. That is said to be the reason why some school teachers are dry.

Fresh air is air that is cool, in motion, free from odor. Pure air is normal air, outdoor air, having the normal percentage of oxygen and carbon dioxide, nitrogen and so on. And we must make the distinction between fresh air and pure air. Modern efficient ventilating systems do what they are built for, namely,

to keep the air pure. They do not and cannot automatically keep it also fresh.*

Mr. Franklin moved that the thanks of the Society be given to Dr. Gulick by a rising vote for his excellent address. (Carried by a rising vote.)

Dr. Gulick: I wonder if a joint committee of this body and the American School Hygiene Association could not secure for us valuable information on these topics?

Mr. Whitten: I move that the incoming president appoint a committee to confer jointly with a committee of the American Hygiene Association.

The motion was seconded.

Prof. Carpenter: I had an interview at one time with Dr. Evans. He wanted to do certain things in a certain building in Chicago which I did not think were quite wise. In his paper he appears to have very greatly modified his ideas from those which he expressed to me. The Doctor assumed at the time of my interview that all ventilating engineers were advocating a

* REFERENCES ON VENTILATION

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1. pp. 363-387.
   Ueber Luftverunreinigung, Warmestaung und Luftung in geschlossenen Raumen, by Prof. C. Flugge, Breslau.
   (This gives a history of experiments and observations in this line and a summary of conclusions)
2. pp. 386-405.
   Ueber den Einfluse wieder Eingesthmeter Exspiration sluft auf die Kohlensaureabgabe, by Dr. Bruno Heymann, Breslau Institute.
   (Account of his own experiments and comparison with other investigators)
3. *Die Wirkungen der Luft bewehnter Raume,* by Dr. L. Paul of the Hygienischer Institute der U. Breslau.
4. *Das Verhalten Kranker gegenuber verunreinigter Wohnungaluft,* by Privat docent Dr. W. Erchlentz, Breslau.
   (Effect of impure warm air, etc., on various cases of disease)

III. *Stable Ventilation: Purpose, Scope and Need for Such Work.* Bulletin No. 98, Veterinary Division, Agricultural Experiment Station, University of Minnesota, Nov., 1906.

IV. *The Respiration Calorimeter,* by W. C. Atwater and F. G. Benedict; Yearbook of Department of Agriculture for 1904.

V. *Report of the Departmental Committee on Humidity and Ventilation in Cotton Weaving Sheds.* Sold by Wyman & Sons, Limited, 109 Fetter Lane, Fleet Street, E.C., London. Price ½d.

down draft system and that we did not consider anything else. He was prepared to discredit the down draft system. I showed him that the ventilating engineers were not tied to any system, either "down drafts" or "up drafts"; that they were simply mechanical engineers who sought to introduce air in proper amounts by such methods as would secure the best results, and that the circumstances were controlling factors.

Mr. Barron: I offer as an amendment, if the mover will accept it, that the committee so appointed shall be a committee of the Society to consider standards of ventilation which we have in the paper of Dr. Evans. However impossible it may now seem, there are standards. We cannot get absolute standards; we cannot get the practical to coincide with the theoretical or ideal. But my idea is that the great work of this Society is to approach a standard; and this committee should consider standards and report, so that finally we may possibly evolve a working standard.

President Hoffman: Does the second concur?

A Member: Yes.

President Hoffman: It has been moved and seconded that this committee will also consider standards of ventilation and report to the Society.

Mr. Myrick: I think they ought to consider also the question of standardizing possibly the engineer. I realize, of course, the great value of doctors, and they generally report in some cases that the operation has been successful but the patient is dead. Now you can't have a man to fix your teeth without passing a certain examination. A doctor cannot practice, a drug clerk cannot put up your medicine without a certain examination. Even a plumber is not allowed to touch your pipes without a license. But a ventilating engineer, outside of the members of this Society, is a man who has his head swelled enough and thinks he is a heating and ventilating engineer. I will admit there ought to be a State authority to say that a ventilating engineer who has been practicing so long should have his knowledge taken into consideration, but that no new engineer shall put up his sign until he shall pass an examination.

Dr. Evans possibly is advocating an upward ventilation and somebody else downward, but the whole thing is a farce. Seventy-five per cent. of the schools of New York State have an

expensive system of aspirating coils and things like that that are not in use. We have been trying to get a Publicity Committee, and apparently we come to the point that we don't know anything about the subject, and that nobody else does; and still we expect to have some laws that we must push a certain kind of thing and put it through.

Now it seems to me that in a Society, the name of which is Heating and Ventilating Engineers, we are conflicting with each other. We ought to get together and have some standards, or we had better dissolve this association. We go along year after year to get at a standard, and finally admit that we don't know anything about it—what do we come here for? There are inquiries about proper heating and proper ventilation, and yet we don't know what to advise. That was the experience of this Society at Albany last year. One man says CO_2 and another says anemometer test, and the legislature says go back and learn something about it.

I suggest that we ought to be ready before we go before the people who make laws for us, so that we can undertake to tell them something. We cannot afford to go before the legislature unless we have consulted together in this Society and know in the first place what we want.

CCXXXVII.

VENTILATION OF THE CAPITOL, WASHINGTON, D.C.

BY NELSON S. THOMPSON.

(Member of the Society.)

In accordance with the request of Professor James D. Hoffman, I take pleasure in presenting the following report of Passed Assistant Surgeon Norman Roberts, Hygienic Laboratory, United States Public Health and Marine Hospital Service, on the ventilation of the Capitol, Washington, D. C., with some comments thereon by Mr. H. C. Russell, a candidate for membership in the Society, and a brief description of the apparatus to be used by the office of the Supervising Architect, Treasury Department, in determining the purity of the air in buildings under its control. I am of the opinion that the Society should convey its thanks to Doctor Roberts for permitting his report to be presented, as I deem it a valuable document and one which will interest the members.

The following is the report of Dr. Roberts:

" In this examination there were made one qualitative test for sulphur compounds, one for carbon monoxide, four quantitative determinations of ammonia, and forty-two of carbon dioxide.

"The test for sulphur compounds indicated their presence, but in such small quantity as not to justify the very considerable labor of determining the exact amount present. Sulphur compounds, mainly the dioxide, are present in greater or less amount in the air of all large cities, or in general, wherever coal is being burned in any considerable quantity within a number of miles to the windward, but are of no hygienic significance unless in considerable concentration.

"The test for carbon monoxide (furnace gas and illuminating gas) was negative.

"The determinations of ammonia resulted as follows:

		Grams per cubic meter
House Floor,	(1)	0.00037
	(2)	0.00038
Senate Floor,	(1)	0.00041
	(2)	0.00031

"These amounts of ammonia are without significance under the circumstances.

"The determinations of carbon dioxide are given below in the order in which they were made:

	Parts per 100,000
1. Temporary Laboratory, Capitol Basement (Terrace)	66
2. Same, after longer occupation	77
3. House inlet, just inside door to basement	33
4. Same	30
5. House, Men's Gallery	61
6. House floor, rear of Democratic side	41
7. House basement, at door to engine room (draft into basement)	28
8. House floor, Democratic side, east end	39.5
9. House floor, Republican side, west end	45
10. House floor, Democratic side, near center aisle (Wicklif)	57
11. House attic, shortly after adjournment	32
12. House basement, draft outward into engine-room	47
13. Air inlet, Senate	27
14. Senate attic (in session two hours)	37
15. House attic (in session four and one-half hours)	37
16. House floor, Democratic side, near center aisle (Wicklif)	31
17. Same, Republican side (Keane, New York)	46
18. Senate floor, open space in front of Chair	57
19. Same, back, Democratic corner	39
20. Same, Republican side, between Smith and Stevenson	54
21. Senate inlet	26
22. House duct, to windward of fan	29
23. House inlet	26
24. Same	28
25. House basement, near engineer's office	31
26. Senate floor, front, Democratic corner	48
27. Senate floor, Republican side	60
28. Senate floor, front of Chair	61.5
29. House floor, front of Chair	103
30. House floor, middle row, Republican side	41
31. House floor, front of Chair	50
32. House floor, Republican side, third row	50
33. House floor, Democratic side, front row, near wall	66.5
34. House attic (session two hours)	40
35. Temporary Laboratory, Terrace	80
36. House floor, front of Chair (changes of position)	41
37. House floor, Republican side, fifth row (changes of position)	37
38. House floor, Democratic side, fourth row (changes of position)	29
39. House floor, through pipe, middle of Democratic side	32
40. House floor, back part of Republican side (changes of position)	32
41. House floor, front of Chair (changes of position)	43
42. House floor, front of Chair (one position)	72

"The permissible limit of carbon dioxide in the air has been somewhat arbitrarily fixed at 20 parts per 100,000 *above* the amount in the out-door air, i. e., the amount of *respiratory* carbon dioxide must not exceed 0.0002. Hence in this investigation any reading above 48 would ordinarily be taken as indicating undue respiratory contamination and poor ventilation, the mean reading for the out-door air being about 28.

"The process employed for the determination of the carbon dioxide (Pettenkofer's method, slightly modified) is quite exact,

and it is believed that 2 parts per 100,000 represents the extreme error. This error is demonstrated in determinations 23 and 24, which should have agreed. The error resulted from not sufficiently shaking up the vessel after the introduction of the barium hydroxide solution; and reaching a probable maximum of 2 parts per 100,000 at reading No. 24, is believed to have begun at about reading No. 10, the results beginning to be slightly low at this point. The outside air may be considered to contain about 28 parts of carbon dioxide per 100,000 (see readings Nos. 13, 21, 23, 24). The exhaust air from the two chambers showed 32, 37 and 40 parts (readings Nos. 11, 14, 15 and 34), a fair average for this air, during a long session of the house, being probably something less than 40.

"The basement air seems to be quite pure, in consequence of the circulation due to the heat of the engine rooms. Of course, in occupied, poorly ventilated spaces, of which there are a number in the Capitol basement, the air promptly becomes contaminated. This contaminated air tends to ascend into the halls and rooms above, and it is believed that the elimination of the sources of heat in the basement (the removal of boilers and engines when the new powerhouse is put into operation) will prevent this additional contamination of the upper stories.

"The condition of the air on the floors of the chambers was at first a puzzle. The readings obtained from the exhaust air in the attics were low; yet the carbon dioxide readings on the floors varied unaccountably from 31 to 103 parts per 100,000. This wide and irregular variation was finally accounted for as follows: The specimens were taken by sucking the air out of the bottle by a rubber tube, into the lungs, the air from the room filling the bottle at the same time, care being taken to discharge the expired air from the lungs away from the bottle; and where there was a constant strong air current, as in the air inlets and outlets, none of the carbon dioxide expired from the experimenter's lungs got into the flask and the readings were low. On the floors of the chambers, however, the motion of air was very slight, and the experimenter's breath contaminated the whole atmosphere for a radius of several feet from his face, including, of course, the portion of the air from which the sample was drawn. On the other hand, when precautions were taken to escape this contaminated air (as by taking the specimen through

a pipe from below the floor, No. 39, or by moving while taking the specimen), the readings were again relatively low. The effect of this is shown by results Nos. 41 and 42, in which the conditions were practically identical, except that in one case the examiner moved about, while in the other he stood still, and, holding the bottle well out of the way during expiration, held the bottle as near as possible to the face during inspiration, so that the air which went into the bottle very accurately represented the air as it is actually breathed by the members on the floor during a session. At first sight it would appear that the results obtained when part of the carbon dioxide in the sample came from the experimenter's own breath should be considered of no value. On the contrary, when controlled by experiments in which this factor is eliminated, they are highly instructive, since they show that conditions are such that although an abundance of air is supplied, the distribution is faulty, and the members occupying the floors of the chambers rebreathe their own breath, while a large quantity of pure air passes unchanged and unmixed through the chambers to the outlet."

APPENDIX TO THE REPORT ON THE ANALYSIS OF THE AIR AT THE CAPITOL.

"The method employed for the determination of the carbon dioxide was a modification of Pettenkofer's method, as follows:

"Several glass containers, holding in the neighborhood of 4,000 c.c., were measured as to their cubic capacity by weighing first when empty and dry, and then when filled with water. Erlenmeyer flasks with mouths about 1½ inches in diameter were preferred on account of the convenience in cleaning and drying, but not enough of these were available and bottles of the ordinary shape had to be used sometimes. These containers were stopped with rubber stoppers, which in turn were bored with a hole about ⅜-inch in diameter, and closed with a small, hard, red rubber stopper. In taking the sample the air in the bottle was sucked out by a rubber tube reaching to the bottom, the larger stopper being removed. About 10,000 c.c. of air, on the average, were passed through the bottle; the mouth was then tightly closed and the bottle taken to the laboratory. Fifty cubic centimeters of barium hydroxide solution of known strength (see

below) were introduced by means of a burette through the hole in the large stopper, the small one being removed. The flask was then again tightly closed and set away for an hour or more, the contents being gently agitated at intervals. (The occasional agitation appeared to be necessary to complete the absorption within a reasonable time.) In the meantime some of the same barium hydroxide solution was titrated against the standard oxalic acid solution as follows: 25 c.c. of the barium solution was run from the burette into a 100 c.c. volumetric flask, and one drop of one per cent. phenolphthalein solution added, producing a deep red coloration. From another burette the standard oxalic acid solution was added until the color was exactly discharged. The oxalic acid solution contained 2.819 grams of acid to the liter, and one cubic centimeter was equivalent to 0.5 c.c. of carbon dioxide at 0 degree C. and 760 mm. pressure. The value of the 50 c.c. of barium hydroxide solution being thus determined, and sufficient time having elapsed for the complete absorption of the carbon dioxide in the sample of air in the 4,000 c.c. container, a drop of the phenolphthalein solution was introduced into the latter, a final shake given to color the liquid uniformly, the small stopper removed, and the nozzle of the burette containing the oxalic acid solution introduced, and the acid run in until the color was exactly discharged. The difference between the strength of the barium solution weakened by the carbon dioxide in the large container, and of the unaltered barium solution, represents the amount of carbon dioxide in the sample. A correction for temperature and pressure must be made, and for convenience a table covering the ordinary ranges of temperature and pressure may be made.

"The following is a sample of the results:

Determination No. 16, 4:50 p.m., March 29, 1910.

Floor of House, just after adjournment; Democratic side, near center aisle (Wicklif, Louisiana)

Temperature, 25.° C. Correction factor, 92.3%.

Barometer, 30.16 in.

50. c.c. $Ba(OH)_2$ sol. (unaltered) .... 31.6 c.c. oxalic acid.

50. c.c. $Ba(OH)_2$ sol. (after exposure) .... 29.3 c.c. oxalic acid.

2.3 c.c. difference.

1.15	**0.923**	**1.24**	**1.15 c.c. CO_2 in sample (at 0° C. and 760 mm. pressure).**
	0.00031		**1.24 c.c. at 25° C. and 30.16 in. pressure.**
	4000) 1.24000 (		
	1.2000		**31 volumes of CO_2 per 100,000.**
	.4000		

"This procedure is a slight modification of that given in Kenwood's 'Public Health Laboratory Work,' 4th Ed., London, 1908, pp. 160-168.

"The ammonia was determined by drawing 100 liters of the air slowly through a train of three wash bottles containing ammonia-free distilled water. The air was drawn through a lead pipe opening above at the level of the tops of the desks about midway from front to back of the chamber, and connected below into the 'plenum' or fresh air space below the floor, through a ventilating opening, where it was connected with the train of wash bottles. The absorbed ammonia, 'free' and 'albuminoid,' was then determined as in water analysis, by distillation and Nesslerization. The two varieties are reported together, instead of separately, because it was impossible to make the distillation until the next day, and the distinction is not as significant in the case of air as in water.

"The sulphur compounds were tested for by slowly passing the air through bromine-water in a train of absorption bottles, whereby the sulphur was oxidized to sulphuric acid. This was tested for by the addition of barium chloride solution and dilute nitric acid. The reaction was controlled by parallel tests on (1) a sample of the same water through which out-door air had been passed (at the Hygienic Laboratory), and (2), a sample of the same water untreated.

"The carbon monoxide was tested for by shaking up a liter of the air with a dilute blood solution and comparing the color with that of a similar portion of the same blood solution not exposed to the possible action of carbon monoxide.

"All of these methods are derived, with or without modification, from the descriptions in Kenwood's 'Public Health Laboratory Work' (*supra*), in the section on Air Analysis, pp. 149-198."

It might be well to state that Dr. Roberts makes no pretense to being a ventilating expert except as it refers to hygiene.

Attention is called to the following:

It will be noted that the report always refers to the CO_2 constituent as parts in 100,000, whereas the heating and ventilating engineer usually refers to it as parts in 10,000 parts of air.

The CO_2 constituent in the air intake, readings No. 13, No. 21, No. 23 and No. 24 average 27 parts in 100,000. This is very low reading, and is accounted for by the fact that the air intakes are on the capitol grounds several hundred feet away from the slightest source of contamination and long distances from any serious source of contamination.

The system of ventilation used in the Senate and House chambers is the up-draft, and many of you are doubtless familiar with it. The air is admitted by multiple floor openings, in the legs of the members' desks, etc., and escapes through a perforated ceiling, through which it is drawn by exhaust fans.

The air quantities circulated are sufficient for excellent ventilation, which is evident upon comparing readings 13, 21, 23 and 24 with 11, 14 and 34, the CO_2 constituent increasing from an average of 27 to an average of 35 parts in 100,000, yet the readings obtained at the floors of the chambers were very much greater, one case (No. 29) being 103. In the report above quoted Dr. Roberts explains that some samples were taken while he was standing still in the chamber, while others were made with the experimenter in motion. It seems rational to consider the former as the kind of samples in which we are really interested, because they represent just the kind of air a member sitting still in his seat is breathing. The relatively purer air in the aisle beside him or in the "foul air" space in the attic above him does him no good.

It seems that Dr. Roberts was justified in his conclusion that the distribution is faulty, and that a large part of the air as soon as it entered at the floor took a "bee line" for the ceiling openings and there was little or no diffusion, or at least what diffusion there was took place above the breathing line.

Whether or not better results could have been secured with the downward circulation or some other method is a question on which the experts will disagree, but it is undoubtedly a fact that in this case the upward circulation system had a fair show.

The important point we see emphasized in Dr. Roberts' report is that when we test the CO_2 constituent in an occupied room our result will depend more or less upon where and how

we take the sample. A sample taken in the foul air duct might mean little or nothing, especially if the occupants of the room were sedentary. In this case we should get our samples, as it seems to us, near the occupants' heads and in such a way, as Dr. Roberts did, to represent accurately the same air the occupant was breathing and not the air over his head or beside him. The closer the results obtained from these samples agree with those obtained from the air in the foul air duct the more efficiency we are getting out of a given quantity of fresh air introduced.

DISCUSSION.

Prof. Carpenter: This paper brings out very clearly this one scientific fact, that the air in a well ventilated room can vary greatly in its character in different parts of that room. It appears that the natural diffusion which takes place in the air is not sufficient to neutralize the difference in chemical composition in different parts of the room. In other words, we can have very bad air in some parts of the room and very good air in other places, and consequently the problem of ventilation is not only that of introducing air into the room but it also includes that of perfectly distributing and circulating that air.

At one time I made investigations in the City of New York in very much the same way as indicated by this paper, and we found the same law held true. In schools where plenty of air was introduced to maintain our standards of purity, certain parts of the room were found with very impure air and other parts with very pure air. In other words, the ventilation difficulty was to get perfect diffusion. We found one very gratifying thing: that in the rooms we investigated which had a standard system of introducing and circulating air, the results were generally good and the distribution of the air pretty uniform. In schools, however, where natural draft was depended on, the distribution was very bad, the air was very poor and the teachers and children both suffered from poor ventilation.

I think the points that have been brought out in these physical and physiological papers are very important, because they emphasize the circulation and distribution of the air. These considerations caused the committee to introduce that other require-

ment into our suggested standards, that is, that the ventilation should require not only the proper volume, but it should require the proper circulation, which, of course, means the proper distribution. Those things perhaps are well known, but the physiologists have brought them out in a way that is very interesting and very helpful. They prove that we should not try to get along without circulation. They have also brought out the fact that even with circulation our supply of oxygen may be very insufficient and yet the human body does not suffer as a result.

Now these questions I think are of very great value to us as engineers, and this paper is of value, because it shows that the very costly system, which was employed in this particular case in order to secure perfect diffusion, was no more of a success than the one we ordinarily use, which is very much cheaper and very readily installed.

Mr. Whitten: In regard to the matter which has been given some prominence in these physiological papers, I wish to relate an instance of a test of a school building in connection with a rapid circulation or the rapid delivery and exhaust of air.

In one room which I tested in the school building the air supply was designed or intended to be 750 lineal feet per minute, the rate of travel. It was rather a windy day that this test was taken, the wind blowing about fifteen miles an hour. And we found that in some rooms on the leeward side about thirty-four eighty-seconds of the air went out of the vent. The balance escaped from the room by other means—the greater part through the windows. A test of the air in that room at the prevailing level, which was quite low—the children were small and not particularly clean—showed an average of about 10 parts of carbon dioxide in ten thousand. There seemed to be a stagnated part at the bottom of the room. And it seems to me that unless some means can be taken to insure the circulation of the air in a room and its exit by the provided means, that rapid circulation or rapid delivery of air to a school room in many cases, especially on the leeward side of the building, defeats the object for which it is intended.

Mr. James H. Davis: This paper, as Prof. Carpenter put it, is very interesting at this particular time, from the fact that we have had a paper from Dr. Evans, and being somewhat familiar with what is going on in Chicago I am pleased that this paper

has come just at this time. But those who were present when the report was read from the Illinois Chapter and also the report from Mr. Lewis, they will remember that they are now preparing to do this very thing in the schools in Chicago, that is, with one or two rooms. And it is evident that it has already been demonstrated that its efficiency is no greater, as Prof. Carpenter has put it, than the way we now heat and ventilate our schools. I speak of that because there is a misleading statement in one of the papers read yesterday in an extract from a paper read by Prof. Watt in Chicago, in which he said the air of the schools is dryer than the air of the Desert of Sahara. Now Prof. Watt, I think, also misstated the results obtained in fuel saving by introducing greater humidity.

This author shows us conclusively that we may have contaminated air by introducing the air in large quantities at the floor and taking it out at the top of the room, for he states that there are undoubtedly currents which go directly from the floor registers to the ceiling openings. It can readily be proved by any one who has made a test of hot blast heating that there are streaks of air. If we should take that blackboard as a cross-section representing the outlet of a fan and take our readings of temperatures at any different points, we would find that they all vary; there would be no two alike. And that variation in temperature we would find on introducing air at any point.

I am very glad the Professor has brought out the fact that the present method of ventilating schools, both in New York and in Chicago and in the large cities, is not so defective as some of the newspapers would lead the general public to believe.

Mr. Whitten: We have a very diffident member with us, from whom I, for one, would like very much to hear, Mr. Moore, of Massachusetts, who has had a large experience in this matter.

Mr. Moore: I was very much interested in Prof. Carpenter's statement, and I think he has, to use the expression, hit the nail on the head. As to the underfloor updraft system, it would practically be prohibited in Massachusetts on account of the cost, it would be so large, for the law requires that all ducts conveying heat or air for ventilating purposes shall be made of incombustible material. Now in order to put in an underfloor system, the ducts would have to be made of metal, the construction of the building would have to be changed and the installation would be

practically impossible. I perfectly agree with Prof. Carpenter in his conclusions.

Mr. Lewis: It would perhaps be interesting to note the result of some experiments that have been made in the Chicago Normal School by Prof. Shepherd of the Chicago Ventilation Commission. Having a chemical laboratory in the building, it is possible to get hydrogen, and a number of small balloons were liberated in standard class rooms. A piece of old rubber tube was hung on each balloon and cut off as necessary until the balloon was balanced perfectly. Then these toy balloons were freed near the air inlets, in standard class rooms, while they were occupied. It was found that it would be necessary, in order to get anything like proper ventilation, to put diffusers of some kind on the fresh air inlets. The air, as shown by the balloon, would shoot right across to the far side of the room, sometimes not spreading out at all. Coming over to the outside wall, the balloon would drift directly down to the floor, then perhaps it would move up very slowly until it came over a pupil, then it would rise up a little bit, then settle down again, as soon as it cooled off. The heat given off by a person was enough appreciably to raise the delicately balanced balloon. It is apparent that Dr. Evans is right in asking for better ventilation than that gained by the dilution principle. We must build our buildings better, we must insulate them better, before we can get perfect ventilation. Every cold surface makes a down current; every hot surface makes an up current. These improve ventilation if properly applied, but in present practice they are liable to destroy the efficiency of ventilation by dilution.

I think there will come a time when we will not put radiators under the windows in ventilated rooms, as they destroy the current scheme of ventilation by dilution. The radiators so located set up a counter circulation opposed to the ventilation circuit, especially when the air inlets and outlets are on an interior wall. With radiators under the windows, the heat loss from a room is increased, owing to the greater difference in temperature between the inside and outside of the wall.

I have had, I suppose, fifty school rooms with direct radiators which were not put under the windows, and have not had any complaints due to the cold on account of the location of the radiators. I think we should work for double windows and

walls, thoroughly furred, to get rid of the local cooling effect, rather than counteract poor construction by piling radiation up against it.

President Hoffman: Were these radiators put along the bare wall between the windows or on the inside wall?

Mr. Lewis: I have never had experience with radiators entirely on the dead side of the room. However, in a number of instances in rooms in which one side was glass and exposed wall I have put the radiators at right angles to the glass and exposed wall not far from them, with satisfactory results.

Mr. James H. Davis: In regard to the introduction of air with a sweeping effect, it occurred to me that a device could be arranged to be placed on the room outlet similar to those which we have on little electric fans, so that a current of air would sweep in a like manner forwards and backwards. This could be operated by compressed air or electricity, and would give a sweeping effect and would thus throw the warm air all over the room.

Mr. Franklin: In this excellent paper I note that the largest defects seem to be in front of the speaker's chair, both in the Senate and the House. Now wouldn't that show that there was not sufficient provision made for what we might call dead spaces? Under each chair there is an opening admitting air and allowing it to be diffused; but here is a large space in front of the speaker's chair in which there was evidently no provision made, as it was not thought necessary because there were no officers in that space. If it is necessary to have the ventilation perfect all over the room, provision should be made for these unoccupied spaces.

Mr. Macon: It is highly important, in testing indoor air for the amount of carbon dioxide it contains, to have some knowledge of the proportion of carbon dioxide in the air supply. In some tests made of the outside air on the roof of the Custom House in New York City, Mr. Cooley, of the Supervising Architect's Department, found that at this point, which is near the Battery and presumably pretty well wind swept, the proportion of CO_2 in the outside air ran as high, I think, as 7 parts in 10,000. The importance of this phase of the subject has been recognized in the proposed new law for factory ventilation in New York State. The committee having this matter in charge had to bow to the

wishes of other interests which contended that carbon dioxide should be recognized as the vital element in ventilation, and we settled on a differential. It complicates the matter by making it necessary to test both the indoor and outdoor air.

The proportion of carbon dioxide in a given indoor atmosphere has commonly been regarded as an index of the ventilation of the apartment, on the ground that ventilation is required to dilute to a maximum extent the so-called or assumed poisons of expired air. The late investigations of physiologists indicate, however, that poisons in the human breath do not exist.

Assuming that there is nothing of a poisonous character in the average human breath, ventilation to offset the effect of expired air would seem to be required principally to minimize the danger of contagion from pathogenic micro-organisms projected from the mouth. If the movement of air provided in a room can carry away the harmful bacteria, then one of the desirable features of ventilation has been secured. It is possible that contagion can occur even with a high movement of air over the body, owing to the fact that these germs may be sent considerable distances from the mouth in coughing or speaking, but generally speaking it is acknowledged that bacteria have no powers of self-locomotion and tend to gravitate. At any rate, dust particles are assumed generally to harbor bacteria in large numbers, and so a ventilating system should be one minimizing dust agitation.

The carbon dioxide test tells us nothing with regard to the existence of dust. Tests for the amount of bacteria in the air and the kind of bacteria do not seem to be highly successful or at least highly practicable. And investigations of physiologists indicate that the question of contagion by bacteria is only a part of the story, and that the up-keep of the proper heat exchanges of the human body and the maintenance of conditions, taxing the nervous system to a minimum extent, are important.

The carbon dioxide content of an atmosphere tells us nothing with regard to the temperature of the atmosphere or the humidity, and these are important conditions, as elaborate experiments of physiologists have shown, affecting the heat exchanges of the body and the general conditions maintaining health. If the strength of the body is kept up, it is one of the recognized facts of medical practice that the body then is in a

position to overcome the chance of bacteria to get a hold on the system.

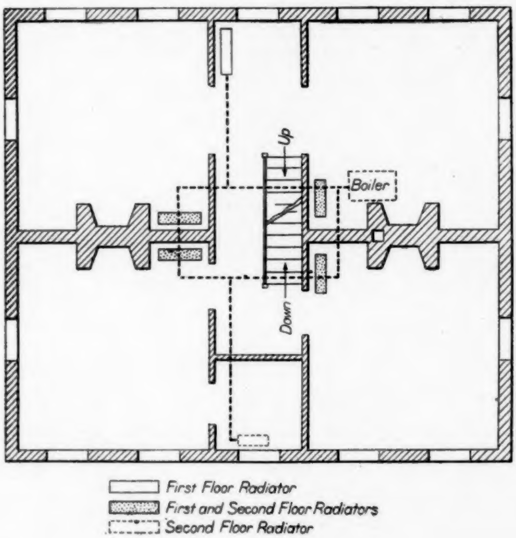
Even if carbon dioxide is employed as the standard for ventilation, the method of determining it with any degree of accuracy is not especially simple and requires rather cumbersome apparatus. It is recognized that at least one portable apparatus has been perfected, seemingly the last word in apparatus of this kind, but in the case of a controversy, or in the proper administration of a ventilation law, a considerable number of samples of air of a given room would be required and considerable time would be needed to ascertain results which many times have to be correct within one one-hundredth of 1 per cent., or else the ventilating scheme is condemned.

President Hoffman: I would like to explain a case which came to my notice. In some of the lecture rooms at our university, having capacities varying from 300 to 400 students, we have found it a difficult matter to obtain a uniform circulation and distribution of pure air in all parts of the room. In most cases the rooms have raised seats. In our last effort we adopted the old-fashioned scheme of opening up one large duct with a full supply of air into the space below the raised floor, having the air outlets in the risers below the seats. This space below the raised floor serves as a plenum chamber. The openings into the room are 1-in. diameter, and are pitched upward so that the air will not strike the floor. The number of openings is sufficient to permit the required amount of air to enter at a velocity so low that it can scarcely be noticed 1 ft. from the opening. All the air is exhausted at the front of the room near the floor through large registers leading to the attic.

We have so far made no tests in this room for carbon dioxide, but I know of a number of people, who claim to have fair discernment in the matter of pure air, who have come into the room from the fresh outside air on both cold and warm days, and who say that they can detect little or no odor after a class of 300 men have been in the room for an hour. I myself have tried it, and I could detect just the slightest odor upon entering. This is a fairly severe test, since the vent registers are located by the side of the doors and all the vitiated air passes these points. The circulation at the back part of the room near the top, where we would expect the most impure air, is probably the best.

This merely goes to show that the practice of admitting the plenum air from underneath the seats through a large number of small openings and withdrawing it from the front of the room by natural circulation to the roof is giving satisfaction with us.

Mr. F. K. Davis: In reference to the inquiry of Mr. Lewis, concerning the placing of radiation on inside walls, I can probably give you some information. This diagram on the blackboard shows an installation made about two years ago. (Illustrates on blackboard.) You will realize that there is very little



outside wall space that is not taken up by the windows. The window sills are about ten inches above the floor, and the top of the window runs to within eight inches of the ceiling. There was so little space in the rooms for radiation that as a final solution radiators were placed as shown in the diagram.

It was a rather novel and untried scheme, and there was some question as to the success, but we had to do the best we could.

This installation has gone through two winters, in which the lowest temperature has been, I think, in one case 8 deg. below, and in another 3 deg. below zero. The owner of the house is a man of more than ordinary intelligence, and he has watched very closely. He tells me that never on any occasion has it been

necessary to exceed a water temperature at the boiler of over 145 deg. to heat his house comfortably, which means usually in excess of 70 deg. F.

The proportion of radiation in these rooms, assuming that 4 sq. ft. of wall is equal to 1 sq. ft. of glass, is a little less than ½ sq. ft. of radiation to each sq. ft. of glass. When I first mentioned this installation the question was raised as to cold drafts across the floor, and it was predicted that this in itself would condemn the plant. I recently went out to the house to get some data. I took an anemometer with me, that was calibrated flat to 200 and very sensitive, and tried that on the floor, to see if there was a perceptible draft across the floor. In no case could I get draft enough to start the wheel of the anemometer, and thermometers hung at the breathing line and also with the bulb about 4 to 6 in. above the floor showed a differential of less than 2 deg.

Mr. Macon: Will you indicate where you had the thermometers?

Mr. Davis: They were hung on the chandeliers in the centre of the rooms. One thermometer was hung on the chandelier so that the bulb would be on the level of the breathing line of an adult sitting in a chair, and the other one was dropped down to 4 or 6 in. above the floor. That seems to show that radiators can be put on the inside walls. Last winter I had an opportunity to get some tests on radiators placed in different places in similar rooms.

Mr. Myrick: But you did not state what the velocity of the wind was that day.

Mr. Davis: About two miles an hour; as near as I could estimate. It was pretty hard to determine with the ordinary type of anemometer, because I find it is almost impossible to get an anemometer to face directly towards the wind.

Mr. Myrick: Was that on the north or east of the house?

Mr. Davis: About northwest or between west and northwest, blowing obliquely on the front. The house was just ordinary frame construction. It was built ten or twelve years ago. I presume, comparing it with other buildings built at that time, that the construction was of 2 x 4 studding, 1 inch sheathing, building paper and weather boarding on the outside, lath and plaster inside.

I had an opportunity for tests in ten houses that were built identically, only in some of the houses the radiation was placed a little different from the others. I spent from ten days to two weeks constantly working at the radiators trying to find out something definite. Originally I was looking for an error in the transmission coefficient of heat from radiators. For example, our coefficient is 1.7 heat units per degree difference in some types of radiators, and with a difference between 70 deg. and 215 deg., yet I have never been able to find the air in contact with the radiator as low as 70 deg. The lowest I ever remember getting with any radiator was a temperature of 84 deg. F. And on a radiator, where the boiler temperature was about 130 deg., the air in contact with the radiator has varied from 84 deg. to as high as 120 deg. on a steam radiator under 1 lb. pressure.

This seemed to indicate to me that there was something wrong with the coefficient, and I was working to that end on these buildings. Some of the radiators were on outside walls, some of them placed at right angles to cold walls, some of them placed on inner or warm walls, and a few of them placed under windows. I found uniformly that the radiators under the windows gave the highest temperature of air in contact with the radiator. Those on the cold walls would more nearly approach that maximum. Those that were placed at right angles to the cold wall seemed to give the best solution, from the fact that the air in contact with a radiator at right angles to the cold wall would be higher nearer the cold wall, and as we came from the cold wall the temperature of the air would drop until between 2 and 3 feet away we would get approximately the same temperature that we would get on a radiator placed entirely on the warm wall. As the proportion of heat transmitted by a radiator is in proportion to the temperature difference of the cooling medium of air in contact with the radiator, it seems to show that the radiator on the warm wall is more efficient and will transmit more heat than the radiator placed on the cold wall or under a window.

Mr. Franklin: I would like to ask the gentleman whether the ceilings of the basement in this house are plastered?

Mr. Davis: No, sir.

Mr. Franklin: Are the boiler and the radiation piping covered?

Mr. Davis: The boiler and piping are covered with the ordinary magnesia covering.

Mr. Quay: What was the temperature outside, the temperature of the air inside at the outside walls and at the windows; and also were the windows of the ordinary open, loose type, and how much air came in through the windows, or were they closed tight so that not much air could come in around them?

Mr. Davis: No thermometers were hung for any considerable period of time at or near the windows, because there was nothing to put them on. Psychrometer tests showed that there was no appreciable difference in the temperature at different points in the room. The heating seemed very even. The windows were tight.

Mr. Whitten: I would like to ask Mr. Davis whether any test was made as to draft at those fireplaces?

Mr. Davis: There wasn't any test made for the draft of the fireplaces because the time at my disposal was very limited. I presume, however, there was a current of air going up the chimney, from the fact that there are no dampers in the flues. In another house, of which this floor plan is typical, an open fireplace in one room, the library, was used almost continuously. After one winter the owner of the house had the radiator in this room removed because they never used it. The room was about 16 x 18 feet, and without any radiator whatever, yet the open fireplace, burning a wood fire in the grate, made the room comfortable even in extreme weather. My personal opinion is that the heated air, drawn from the other parts of the house to that room by the draft in the fireplace, caused that room to be warm without any direct radiation.

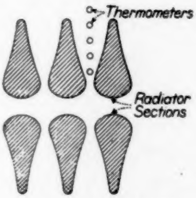
Mr. Teran: I would like to know the method that was employed to obtain the temperature near those radiators.

Mr. Davis: This roughly shows the radiator. (Referring to diagram on page 167.) Thermometers were hung on an improvised rack. Here there was a clearance of from 1/4 to 1/8 in. of air between the iron and the thermometer. Then we placed thermometers further out at right angles, at varying clearances, until no influence was noted. Six or eight thermometers were used simultaneously. There is a belief that a thermometer placed near a heated surface is affected by radiant heat, but I found in every case where I put a paper tube around the bulb of the ther-

mometer that the temperature would immediately rise, showing that there was more radiation from than absorption of heat by the bulb of the thermometer.

Mr. Whitten: I have found in tests of air currents in rooms with windows on the outside wall and a radiator placed below the window that there were two distinct currents, one in which the rising column is met (providing the window is fairly leaky) by a volume of cold air. In that case the heated column immediately falls back again, and makes a sort of revolving curtain over the window and wall. There is another deflected current which comes off and returns immediately to the bottom of the radiator. There is very little current in the remaining space in the room, the air in this space being more or less stagnated or stratified.

In a large number of experiments where I place the radiator on the inside wall, and the best results were obtained with



MR. DAVIS'S SKETCH.

radiators of the flue type, so-called, the warm air currents were found to be coming up over the inner wall, and, if these windows were made tight, going clear to the wall, falling and going back to the radiator. The colder the outside wall and window the more rapid the flow of this current.

I have found the efficiency of the radiator greatly enhanced by putting in a floor register, underneath the radiator, connecting with a cold air duct, so that the regulated quantity of air may be introduced, if found necessary, and circulated through the radiator. If this window was not tight, I found a cold air zone here which the warm air current did not penetrate.

In other words, this revolving circle of air was restricted, but if the wall and window were made tight, the current practically filled the entire room and a general diffusion of heat obtained across the entire room.

Mr. Mobley: I want to say that I agree with Messrs. Whitten and Davis. I have had work in several old buildings that are isolated. The fireplace stoves were all taken out, and as I was not allowed any other place in the room, I located the radiators all under the mantelpieces. With one exception, in one house which was very much isolated, the mantels were in the middle of the room. It happened that I placed these radiators just before the last blizzard, seven or eight or perhaps ten years ago. The day of the blizzard, and we had a very low temperature at that time, below zero, I found the house very comfortable. I had thermometers at various exposed places in the house, which showed my desired temperature of 70 deg. There were no cold effects in that house. It was a house of very ordinary construction, without double weather boarding, and it had ordinarily built windows. I increased the radiators about 10 per cent. when I made my calculations.

Mr. J. Logan Fitts: I would like to call the attention of the members, who are interested in ventilation, to the work that has been done by the mining engineers. They have studied air currents and the handling of air in various ways and also the distribution of air through the passageways and gangways of mines. I have been in the gangway of a mine, and stepped just around a corner and found the effect of gas sufficient to give a decided cap to the lantern. I have also gone through a gangway which was absolutely clear of all noxious gases and put a safety lamp above my head into a little cavity in the roof and found quite a mass of gas. That illustrates the necessity of the distribution of air throughout any chamber that you want to ventilate thoroughly.

Some years ago I designed and manufactured an instrument for testing mine gases. During the progress of that work we conducted a large number of experiments, which consisted in the determination of the quantity of CO_2, CO, of ammonia, mine gas or marsh gas, etc. We developed a system of testing for these various gases, in which we used a solution of lime water of known strength; for instance, to test for carbon dioxide. We passed a certain mixture of carbon dioxide and pure air through this solution, letting it bubble up from the bottom of the test tube and out, and we were able to make true determinations of the ratio of CO_2 in the ordinary air by comparing the turbidity

of the lime water, after having passed definite quantities of the air under test through the same, with the sample made by mixed pure air and a known quantity of pure CO_2. After many determinations of an experimental character we found this method to be accurate and satisfactory.

We made some tests of the air in theatres in Philadelphia. I also made some tests of the character of the air that came off the surface of the street, when gas was leaking from mains, to locate the gas leak. I also made some experiments with a live rat, putting it under a bell jar and pumping into this jar a mixture of air and a known percentage of CO_2. We were able to put the rat to sleep, not permanently, however, for after pumping in a portion of fresh air the rat would revive and be apparently as lively as ever.

This instrument has never come before the public in a general way, but it seems to me that a method of this sort, using an instrument for pumping the gas through solutions, and using the usual reagents, phenolphthalein and others, would be decidedly useful. We also had a process for carbon monoxide, which is difficult to detect and analyze, requiring quite an extended chemical treatment.

The method of obtaining samples for use in the instrument was very simple. A diaphragm pump operated with the fingers was designed, with a ¾-in. brass tube with tapered ends to each section, very much the same as a vacuum cleaner, and we could connect these sections and reach to the ceiling or to a pocket of gas in the mine, and pump this gas into a rubber bag, holding say 5 or 6 gallons, sufficient to make a thorough test. We could make a test and note the condition of the air in 10 or 15 minutes after the sample was taken.

Mr. Ingalls: Some years ago in making ventilating tests in a theatre building, I obtained air specimens in a manner very similar to that described in this paper. Two litre bottles were used, and samples were taken in four parts of the audience room, simultaneously and at definite intervals, while a public performance was in progress and a good sized audience present. Under such conditions the operators could not move around, nor had they much latitude of operation, each occupying an assigned seat in the midst of the theatre patrons.

As may be noted, the handicap of a cramped sphere of opera-

tion might have been expected to cause serious contamination of the sample by the operator, the results, however, proved differently. Very few, if any, of the samples taken show evidence of contamination, and many of the series check each other absolutely, indicating the sample to be true, and unaffected in any way by the operator.

CCXXXVIII.

REPORT OF COMMITTEE ON THE EFFECT OF AIR LEAKAGE AND WIND VELOCITIES ON HEATING GUARANTEES.

This report sets forth a few specific examples, and is intended to be one of progress only:

Harvard Medical College:

A large group of buildings heated from a central plant by means of a forced hot water system. Direct radiation and indirect fan system. Fans in use from 8 A.M. to 6 P.M., Monday to Friday, inclusive. Saturday fan in use from 8 A.M. to 1 P.M., Sunday direct only. Use of buildings is such that conditions on one day of the week will compare nearly with same day of the following week. B. t. u. supply determined by recording thermometers on supply and return. Venturi meter determines amount of water circulated. Manometer readings hourly.

Wind velocities and direction and outside temperature taken from U. S. Weather Bureau records at Federal Building, Boston.

A table showing comparative days of week for January and March, 1910, from the Chief Engineer's log.

The buildings are of high-class construction, and have usual proportion of windows compared with wall surface. Glass area not excessive.

Extract from Report of Tests of Gymnasium Buildings at Michigan University by J. E. Emswiler, Mechanical Instructor, under Supervision of M. E. Cooley, Dean of the Engineering School:

"Men's Gymnasium.
Exposed on West, South and East.
Usual number of windows and doors.
Large and very leaky skylight.
Three doors leading to basement.
Heated and ventilated by Fan System.

DATE.	Total B. t. u. Supply. 24 Hours.	Av. Outside Temp., 8 A.M. to 6 P.M. Hourly.	Av. Outside Temp. 6 P.M. to 8 A.M. Hourly Readings.	Av. Wind Velocity, Miles per Hr. 8 A.M. to 6 P.M. Hourly Readings.	Av. Wind Velocity, Miles per Hr. 6 P.M to 8 A.M. Hourly Readings.	Direction of Wind.
SATURDAY.	Millions.	Degrees.	Degrees.			
Jan. 1, 1910........	143	31	35	10.2	16.	S.W.
" 8, "	123	28	26	10.2	6.4	W. & S.W.
" 15, "	232	26	25	20.9	13.8	N.
" 22, "	45	45	37	8.4	16.9	S.W.
" 29, "	100	38	32	10.6	24.8	N. & W.
SUNDAY.						
Jan. 2, 1910........	123	43	36	14.2	9.5	S.W. & W.
" 9, "	131	30	26	3.5	9.	S.W. & N.
" 16, "	143	38	30	6.7	9.1	N.W.
" 23, "	105	39	34	12.4	6.	S.
" 30, "	98	33	32	18.	8.3	W. & N.
MONDAY.						
Jan. 3, 1910........	191	32	21	5.5	21.	W. & N.W.
" 10, "	191	30	17	17.3	11.4	N. & W.
" 17, "	156	34	34	7.4	5.4	E. & S.
" 24, "	131	39	38	5.1	4.7	S. & E.
" 31, "	191	31	27	12.4	15.8	N.
TUESDAY.						
Jan. 4, 1910........	303	6	1	18.	11.6	N.W.
" 11, "	213	26	24	11.4	9.2	W.
" 18, "	111	46	45	16.9	13.1	W. & S.W.
" 25, "	119	37	35	10.1	10.8	N. & E.
WEDNESDAY.						
Jan. 5, 1910........	183	15	32	6.8	8.2	N.W. & S.W.
" 12, "	183	30	28	9.	8.	W. & N.W.
" 19, "	150	40	32	14.3	9.5	W.
" 26, "	109	40	37	9.5	5.5	W.
THURSDAY.						
Jan. 6, 1910........	114	46	40	10.7	6.5	W. & N.
" 13, "	195	30	28	5.5	12.	N.W. & N.E.
" 20, "	136	39	38	8.	7.2	W. & S.W.
" 27, "	127	36	37	7.6	14.2	W. & N.
FRIDAY.						
Jan. 7, 1910........	121	35	24	15.2	10.7	W.
" 14, "	221	26	18	27.1	24.7	N.E. & N.
" 21, "	79	46	52	15.8	27.	E. & S.
" 28, "	103	38	35	8.7	10.7	W. & N.

DATE.	Total B. t. u. Supply. 24 Hours.	Av. Outside Temp., 8 A.M. to 6 P.M. Hourly.	Av. Outside Temp. 6 P.M. to 8 A.M. Hourly Readings.	Av. Wind Velocity, Miles per Hr. 8 A.M. to 6 P.M. Hourly Readings.	Av. Wind Velocity, Miles per Hr. 6 P.M to 8 A.M. Hourly Readings.	Direction of Wind.
TUESDAY.	Millions.	Degrees.	Degrees.			
March 1, 1910......	99	39	36	16.	10.	N.E.
" 8, "	94	37	30	6.6	7.3	W. & N.W.
" 15, "	142	40	32	17.3	9.8	W.
" 22, "	47	50	48	7.1	8.7	S.W.
" 29, "	53	67	58	14.	6.	W.
WEDNESDAY.						
March 2, 1910......	138	38	35	15.	18.	W.
" 9, "	117	40	29	10.	11.8	W. & N.W.
" 16, "	129	45	34	11.7	10.6	W. & N.
" 23, "	91	43	37	10.7	5.	E.
" 30, "	65	50	45	9.8	7.3	E.
THURSDAY.						
March 3, 1910......	93	45	42	12.	9.	W. & N.W.
" 10, "	114	34	30	8.6	6.2	N. & N.W.
" 17, "	131	29	22	12.6	10.6	N. & N.W.
" 24, "	70	55	53	14.6	16.	S.W.
" 31, "	65	43	43	11.4	10.5	E. & S.W.
FRIDAY.						
March 4, 1910......	81	43	42	10.	8.	W. & S.W.
" 11, "	112	36	33	8.5	6.2	N. & N.E.
" 18, "	103	35	31	8.7	7.	N.W. & S.W.
" 25, "	30	72	50	18.9	11.3	S.W.
SATURDAY.						
March 5, 1910......	49	50	42	10.5	8.	S.W.
" 12, "	104	36	34	18.4	11.	N. & N.E.
" 19, "	39	44	42	12.8	13.	S.W.
" 26, "	49	49	43	17.9	10.5	N.W.
SUNDAY.						
March 6, 1910......	52	40	45	8.4	10.	E. & S.
" 13, "	78	39	38	12.4	8.7	N. & W.
" 20, "	26	61	43	18.5	11.	S.W. & N.W.
" 27, "	70	43	38	10.7	10.	W. & N.W.
MONDAY.						
March 7, 1910......	94	44	34	13.1	14.	W.
" 14, "	145	36	28	19.	12.	W.
" 21, "	79	43	37	8.7	13.	N.W. & S.W.
" 28, "	85	50	49	16.7	13.	W. & S.W.

Inlet ducts in north wall above running track (approximately second story), vent ducts in north wall at basement floor.
Area fresh air openings, 32.31 sq. ft.
Area vent openings, 33.45 sq. ft.
Floor registers in main floor at east and west walls.

"A series of tests were made in the spring of 1909 to determine leakages around doors and windows and the effect of leakage on vent flow. Most of the windows showed leakage at bottom or sides of sashes and between sashes. This was ascertained by means of a special funnel, having one end in the form of a long narrow opening, designed to fit over a crack at bottom or side of a door or window sash.

"From this end the shape gradually changed, until, at the other end it became circular, and of the size of the wheel guard of an anemometer. When the funnel was placed over a crack with the anemometer in place, if there was an appreciable leak through the crack, it was indicated by the movement of the anemometer wheel. While this did not provide a quantitative measurement of the leakage it did afford an excellent means of comparing the leakage at different places. The velocities read ran as high as 100 feet per minute to 18-inch length of crack, and in an especially bad case as high as 350 feet per minute. Leakage tests were again made in the spring of 1910 after the windows had been equipped with a metal weather strip; no leakage could be detected except in one case due to a bad sash. Leakage at cracks of doors showed a reading of about 300 feet per minute.

"In the tests of 1909 the fan supply was 25,350 cubic feet per minute, and the average vent volume was 7,100 cubic feet per minute or 28 per cent. of the supply. All windows and doors were closed during tests.

"In the summer of 1909, all windows were equipped with an expansion joint metal weather strip. In the spring of 1910 a series of tests similar to those of 1909 was made.

"During these tests the fan supply was 22,000 cubic feet per minute, and the average vent volume was 11,190 cubic feet per minute or 49.5 per cent. of the supply.

"The foregoing shows primarily the effect of leakage, as the wind conditions in 1909 did not differ greatly during the different tests. In one test in 1909 with stiff breeze from S. E., the vent flow was 7 per cent. less than with a slight breeze from the N. E.

Women's Gymnasium.
Exposed on north and east sides.
Large and leaky skylight.
One door leading to basement. Fan System.
Inlet ducts in south wall, same height as in Men's Gymnasium.
Floor registers in main floor north and east sides.
Vent ducts in south wall of basement.
Area fresh air openings, 20.46 sq. ft.
Area vent ducts, 18.13 sq. ft.
Fan supply, 1909, 10,750 cu. ft. per minute.
Amount at vent with stiff S.E. wind, 1780 cu. ft. per minute.
Amount at vent with slight N.E. wind, 4000 cu. ft. per minute.
All windows weather stripped in 1909.
Fan supply, 1910, 9530 cu. ft. per minute.
Amount at vent, 4170 cu. ft. per minute.
Negligible variation on account of wind noted after weather stripping."

The foregoing shows the effect of leakage and wind both to some extent.

In all the tests it is assumed that the leakage from doors and skylights was fairly constant, as no attempt to standardize this leakage was made. It is the opinion of your committee that a study of the foregoing examples will demonstrate the fact that leakage and wind velocities cause a great range of effect on interior conditions of heat and ventilation, much greater than commonly supposed.

We deplore the fact that the lack of time has prevented a greater accumulation of data, and trust that future committees may be enabled to gather more information along this line. If we can approach the standard used in Germany, much controversy between engineers and heating contractors on the one side and owners and architects on the other will be avoided. It is manifestly unfair for an architect to make plans and specifications for a building and require a heating contractor to heat the "plans" to 70 degrees, or anything else, in zero or other weather. The variation in amount of free opening about doors and windows is very great.

It will be recalled that C. B. Thompson, after spending some time in research work in Germany, said at the semi-annual meeting of this Society at Niagara Falls in July, 1908, "What is known as the German co-efficient of heat losses is used and accepted as a standard all over the continent of Europe. The German co-efficient for glass had nothing whatever to do with the way the sash is fitted to the frame, and, when you come to think of it, it would be impossible to give a co-efficient for the glass and the leakage about the sash, because one might be tightly fitted and another ¼ inch away from the frame as you describe.

If this Society can get together sufficient data to establish a set of standards for the guidance of heating engineers, architects and owners, it will have accomplished a great work. With an accepted set of standards a heating engineer who installed work in accordance with such standards would collect his pay and not wait, as he now has to, until cold weather to test the apparatus before he can get a final settlement. In Germany all that is asked of a heating engineer is to install the heating apparatus in accordance with Rietschel's Formulæ. Then, if the heating apparatus does not heat, the builder is called upon to make good."

Capt. Anders B. Reck, of Copenhagen, told one of our members recently that the plan of procedure in Germany was substantially as follows:

The government has a set of standards for different classes of construction. Building plans are submitted to an engineer or contractor who lays out his heating plant in accordance with these standards. The layout is inspected and, if correct, is O.K.'d by a Government inspector. After the plant is installed it is tested by a Government inspector and, if properly installed, the contractor's bill is O.K.'d by the inspector. The contractor does not have to wait a heating season for his money. If the building does not heat satisfactorily in cold weather, the inspector is again called in and his verdict is almost invariably "fix up your windows."

Your committee is confident that members of this Society, particularly those interested in central heating plants, have large quantities of data bearing directly on this subject. Such data would enable a committee to tabulate and report information which could be used in formulating a standard.

We recommend that the committee be enlarged so as to include members who have access to such data, and are willing to obtain it for the Society. This Society should eventually confer with the American Institute of Architects, The National Association of Master Steamfitters and kindred bodies on this subject.

Very respectfully submitted:

D. M. Quay,
H. W. Whitten, } *Committee.*
George Huey,

DISCUSSION.

Mr. Whitten: I have plotted these results on charts, showing the variation in temperatures, wind velocities and heat units. These examples, in January, are interesting. January 19th and 26th are at practically the same temperature. An average of these will be found to be very close. The wind of January 19th was an average of about fourteen miles an hour, and the higher wind velocities occurred during the day. The difference in the amount of heat required for those two days is somewhere about 40,000,000 B. t. u.

Here is a case of Sundays, when there is only direct radiation in use, and there are some interesting conclusions to be drawn from them. We have an average warmer day on January 9th than on January 16th, but a somewhat higher amount of wind, and much more heat is required. Comparing January 23d and January 30th, the latter is a slightly colder day, but there is slightly more wind on the 23d, and a corresponding variation in the heat.

There are one or two examples in March that will be interesting. Here are Fridays, and it will be noted that between March 11th and March 18th there is quite a material (about 10,000,000 B.t.u.) difference in the amount of heat required; on March 18th there is an appreciably lower temperature than there is on March 11th and about 10,000,000 more B.t.u. required on the warmer day, due to the fact that there is a higher velocity during the entire twenty-four hours than on the day of March 18th.

In endeavoring to analyze these charts or deduct something from them, I have found what appears to be conclusive evidence that the effect of wind during the period when the fan was in use was very much more noticeable than when it was not; for apparently the fan would cause a plenum in these buildings, and the outward flow on the windward side of these buildings was accelerated thereby.

Prof. Carpenter: I notice you referred to the German coefficient of heat losses.

Mr. Whitten: Mr. Thompson refers to it.

Prof. Carpenter: I wish he were here. I have been trying to find if the Germans had made independent experiments. The German coefficients seem to be based on Peclet's investigations, translated from French into German.

Box deduced many formulas for heat transmission, but an examination proves that those formulas are all based on Peclet's experiments.

Now if there is any information as to other experiments I would be glad to be referred to it. We have not found any description of such experiments in German literature, although we have found a list of coefficients, which apparently are based on Peclet's experiments. I have been led to believe in view of that fact that Rietschel merely did as Box did, translated Peclet's experiments. They have then come back to us from another language.

Mr. Barron: I want to ask Prof. Carpenter if I am to infer from his remarks that the coefficients are merely assumed or invented for the occasion by the reputed original author.

Prof. Carpenter: Oh, no; I am very sorry to have that inference drawn. Peclet made a lot of original investigations and actually measured the heat transmission. His work was done 1850 to 1870. He was a noted French physicist.

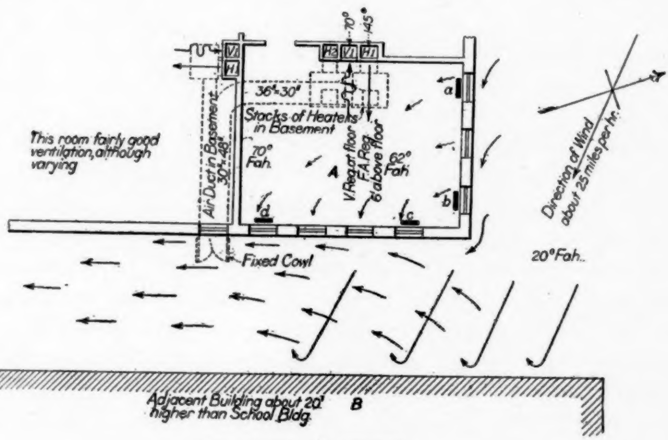
There was a reference in the paper to the German coefficient, and I was anxious to find out if there was any German experiments on which such coefficients were based. I cannot find that there are any.

Mr. Whitten: I might say that the committee have recommended that future committees on this subject be enlarged to take in members who have log-book information on this line. I am of the opinion that there are log-books, which not only contain, in a very accurate manner, the amount of heat used for particular buildings for a period, but also wind velocities, directions of wind, and temperatures for the same period, a large number of them being steam plants, and that condensation for twenty-four hours is taken as the amount of heat used.

I think I made a discovery that is of great importance, that the losses which appear to be most affected by the wind supply did not check up regularly. What I mean by that is that in the period where the high wind velocity occurred during the day, the loss was almost invariably very much greater when the fan was in operation; showing that there must have been far greater losses, due to these wind effects, from the fan system than there was from the direct system. That is not entirely due to the fact that there was less heat during the night than during the day.

Mr. Cooper: I would like to ask Mr. Whitten what effect he considered the position of the building and the surrounding land to have on the wind pressure. Those buildings have high hills, as I remember it, to the westward. Where the velocity of the wind is taken is at the Government postoffice, and I imagine the land is quite open. When they might get a high westerly velocity of wind at the Government postoffice, the buildings might be in a practically dead calm.

Mr. Whitten: The hills Mr. Cooper speaks of are a mile and a half or two miles away towards the north. The building is situ-



MR. BARWICK'S SKETCH.

ated at the south end of the so-called Back Bay, the hills being on the west. There is a high hill on the south, and the south winds that occur during these tests are very infrequent; but on the other three sides there is a very broad sweep of practically unoccupied land.

Mr. Barwick: The accompanying sketch is intended to represent a school building A, and its immediate surroundings. The adjacent building B is in the position shown. Fresh air inlets for the air supply, and exhaust outlets for the ventilation, are indicated. The adjacent building is about 20 feet higher, and about 20 feet away.

When the wind was blowing from the northwest I found that I could get very little air in the room A through the register. The wind would strike the adjacent building and follow the

lines shown by the arrows, causing the air to vary in the fresh air registers, so that instead of a steady inflow at the register, there would be an outflow at times; that is, I could get a varying amount from nothing to 300 ft. velocity, and then suddenly reversing, so that my readings for one minute would show that there was no air registered.

I placed a temporary wind shield over the fresh air intake, and this, I found, corrected the difficulty. I then erected a permanent shield.

The room had three windows on the north side and four windows on the east side. Placing my anemometer on the window-sill at *a,* I found there was an appreciable inflow through the closed window, caused by window leakage. Placing it at *b,* I found there was an inflow and outflow, also due to leakage. Testing at *c* there seemed considerable leakage, and at *d* considerable outflow; these acted as a check on the inlet from the fresh air register.

Opening the window at *a*, of sufficient area to equal the size of heat flue or register, there was a positive inflow through this opening, and slightly less volume in the outflow in the vent register. Closing this window, and removing my anemometer to the window *d* and opening the same in proportion to the vent register, there was an outflow, and the vent register was found to be dead, as no air was passing through.

The effect was caused by the high wind striking the taller adjoining building, depressing the current, and sweeping through the space between the two buildings with rapid velocity in the lines shown by the arrows, causing a suction on the east side of the school building, which drew the air through the space around the sash at *c* and *d,* sufficient to prevent the proper operation in the heat and vent flues. Placing the cowl over the intake to the fresh air flue assisted in supplying the air to the room independent of what leaked in and out through the sash. If the windows had been properly weather stripped, there would have been less trouble with the inlet and vent outlet flues.

CCXXXIX.

TOPICAL DISCUSSIONS.

"Objection to the Making of Plans by Manufacturers for the Installation of their Apparatus."

DISCUSSION.

Mr. Barwick: A number of specialties are made which require a certain amount of illustration, and it is necessary in a certain sense for some manufacturers to provide plans and specifications. There are a number of things, however, for which I do not feel that it is necessary or essential that the manufacturers make plans and specifications. I believe that those things can be illustrated by simple drawings or simple descriptions, so that any of our engineers can draw proper plans and specifications for any particular plant that is erected.

Mr. Whitten: To show how far that thing can go, during a trip through the middle west within recent years I found a large number of medium sized jobs where plans of the building would be sent to a mail order house in Chicago, and a working plan of the installation returned, together with all of the piping, fittings, a pipe wrench and various other things, and directions how to put it together—everything all ready to go in, and all based on the plans and the working drawings accompanying them.

Mr. Barwick: I might add a little more to draw the matter out. A great many of those working plans, which are supposed to be passed by parties of that sort, are made from competitive drawings and from drawings which the party sends as a rough sketch. You can imagine how misleading such a sketch may be, especially when the placing of furniture interferes, and also how much alteration is necessary. A great deal is misleading, and I feel that those things should be discontinued as far as possible. From a commercial point of view, however, a man has a perfect right to try and sell all he can and make everything he can to his profit.

"The Desirability of having Ventilating Laws apply to Private as well as Public Schools."

DISCUSSION.

Mr. Whitten: To bring that matter to a head I would move you that it is the sense of the meeting that ventilation laws should apply to both equally. (Seconded.)

Mr. James Mackay: I should say, Mr. President, any ventilating law should apply to both public and private buildings.

President Hoffman: We have no right to dictate to people outside of the Society, but we can state our own opinion of any law.

Mr. Quay: We have heard that the Massachusetts law, and also that the measure that they have adopted or expect to adopt in Chicago, applies to private schools as well as public. I don't see why it should not apply to other buildings.

Mr. Moore: In Massachusetts for a long time we have had that law, and it has worked evenly. We have some parochial schools that are models, we may say, of ventilation, and it has been generally accepted by all bodies as satisfactory.

The question was called for, put to a vote and carried.

TRANSACTIONS

OF THE

SEMI-ANNUAL MEETING

Chicago, Ill., July 6-8, 1911.

CCXL.

SEMI-ANNUAL MEETING, 1911.

First Day—Morning Session.

(Thursday, July 6, 1911.)

The meeting was called to order at 10.30 A. M. by President Bolton.

The Secretary stated that a quorum was present, and on motion the calling of the roll was omitted.

The President: The first item on our program is an address by Mr. George Mehring, representing the Illinois Chapter.

Mr. Mehring: Mr. President and fellow members: In behalf of the City of Chicago and the Illinois Chapter, it is my privilege to bid you welcome. We believe that we have discovered the reason for this recent hot spell. How could it be otherwise with so many heat unit experts casting their solar eyes towards Chicago? Such proceedings are bound to result in a "warm" welcome.

We hope Chicago will live up to its reputation as a summer resort during your stay with us. We hope the ventilating department of the Great Lakes will get into action, and while it may dissipate all the heat units, it will certainly not cool our cordiality or lessen our hospitality.

We hope that the treatment accorded you by Chicago will warrant a continuance of these summer meetings, until the scheme of the Chicago Plan Commission, with its magnificent dream of civic greatness, is realized.

Our scheme of entertainment at that time may be on a greater scale, but our hospitality and welcome will certainly not be less cordial than at present.

Gentlemen, I bid you all welcome.

The President then read his address. (See page 205.)

President Bolton: We have with us to-day a representative of the Chicago Association of Commerce, and will be very glad to hear a word from Mr. Wing as representing that body.

Mr. Wing addressed the meeting, welcoming the Society to Chicago.

President Bolton: The next order of business is communications from chapters. We will call for any communications from the Illinois Chapter.

Mr. N. L. Patterson: Mr. Chairman and members: It has been customary for the Illinois Chapter to render an account of its transactions to the main body at the meeting in January, but it may be stated here that we have held regular meetings from October until May. We have had a large number of interesting papers submitted during that time. Various committees acting under the Illinois Chapter have been working along various lines, and the result, when finally assembled, will, I believe, be of great value to the parent association and to the heating and ventilating fraternity generally.

Our membership has remained practically the same. We have lost two members and gained two.

I want to call on Mr. Lewis, the Vice-President, for a brief statement of what some of the committees are doing of interest to the Society.

Mr. Lewis: There is no formal report from the chapter at this time. The committee to co-operate with Dr. Evans on the Chicago Ventilating Commission has been working faithfully. Dr. Evans is no longer an officer of the City of Chicago. The new incumbent of that position, Dr. Young, has expressed his desire to work with us along the same lines as those of Dr. Evans.

Two of the papers drawn up by this committee have recently been presented, one at a meeting of the Anti-Tuberculosis Association at Denver and one at Los Angeles at the meeting of the American Medical Association. I have secured permission, in case we have the time and care to discuss them, for their presentation at this meeting.

I would like to present a resolution of sympathy and fellowship and good wishes to Mr. James Mackay and his family. He has been very seriously ill for some time, and is still in a critical condition, I understand. He is one of the charter members of the Chapter, past-President of the Society and past-President of

the Chapter; and I move that the greetings and good wishes of the Society be extended to Mr. Mackay.

The motion was seconded by Mr. Weinshank and carried.

President Bolton: Our next order of business is reports of committees. The first is the rather important Committee on Compulsory Legislation.

Mr. Hoffman, the chairman, then read the report.

REPORT OF COMMITTEE ON LEGISLATION FOR COMPULSORY VENTILATION.

Your Committee on Compulsory Ventilation would respectfully submit the following report. Since our last meeting in January considerable progress has been made along the subject of pure air, and we are pleased to predict that better times are just ahead.

The last report received from New York shows the Factory Ventilation Bill still in the balance. This bill is an amendment to the one passed in 1909, and is a credit to the committee, with Mr. D. D. Kimball as chairman, in having had a large influence in its preparation. It is hoped that the bill will pass, although there has been some agitation toward the formation of a commission to investigate the entire factory proposition, and to report back a general bill covering all phases of factory work. Other than this, there seems to be no serious opposition to the bill.

In reading over the present statute and comparing it with the proposed amendment, one is impressed with the improvement. The amendment is very definite concerning the quality of the air, whereas the present law is very vague and leaves the matter to the discretion of the Commissioner of Labor.

Two bases are given for determining the quality of the air, as shown by this quotation from the proposed law. "A workroom shall be deemed to be provided with sufficient means of ventilation if provided with means of ventilation which will supply constantly in all parts of the room air, either of the quality or in the quantity hereinafter prescribed. A workroom shall be deemed to be properly and sufficiently ventilated if the air in the working parts thereof does not contain more than nine parts of carbon dioxide in ten thousand volumes of air in excess of the number of parts of carbon dioxide in ten thousand volumes of the

exterior air, or if there is constantly supplied throughout the interior of the room at least twelve hundred cubic feet of air per hour for each person therein present and employed, and in addition thereto at least one thousand cubic feet of air per hour for each cubic foot of gas burned per hour, such air to be taken from an uncontaminated source; provided, however, that if gases, fumes, vapors, fibres, dust or other impurities are generated or released in the course of the business carried on therein, the room must be further ventilated by providing at the point of origin of such impurities proper hoods and pipes by and through which such impurities shall be collected and removed, and such pipes and hoods shall be connected to exhaust fans of sufficient capacity and power to remove such impurities, and such fans shall be kept running constantly while such impurities are being generated or released."

The question of temperature, which was not mentioned in the present law, is also taken up as follows: "And provided further that the temperature in any factory workroom, except a boiler room, shall not exceed seventy-two degrees Fahrenheit, as determined by the wet bulb thermometer, unless the temperature of the exterior air exceeds seventy degrees Fahrenheit, as determined by the same process, in which case the wet bulb temperature of the workroom shall not exceed that of the exterior air by more than five degrees."

In Massachusetts, our Committee on Compulsory Ventilation is having its ups and downs. Since our last meeting, a commission appointed by the Governor to investigate the subject, presented a bill to the legislature which would provide for an unpaid commission of five members, whose duty it would be to appoint a chief commissioner, two deputies, a register and fifty inspectors, ten of these inspectors to be women. The unpaid commissioners would have power to fix the term of office, adjust the salaries and discharge and appoint employees. This bill had a strong opposition, but at last report has been called up for final vote.

The work of the Illinois committee since the last meeting has been in co-operation with Dr. Evans and the Department of Health of the City of Chicago. A great amount of work has been accomplished, and there is a great deal still to be done. As a result of some of their investigations, two papers were recently

presented, one before the National Tuberculosis meeting at Denver and one before the American Medical Association at Los Angeles. These papers show the spirit of the work that is being undertaken for the improvement of the public health in the vicinity of Chicago.

Indiana fell into line on March 3d, with a ventilation law that is good as a starter. The State committee, with Mr. Weinshank as chairman, working in connection with the Medical Association and Dr. Hurty, the State health officer, succeeded in passing a bill affecting principally the schools of the State. Extracts relating to heating and ventilation are as follows:

First, "The ground floor of all school-houses shall be raised at least three feet above the ground level, and have, when possible, a dry, well-lighted basement under the entire building, and shall have a solid foundation of brick, tile, stone or concrete, and the area between the ground and the floor shall be thoroughly ventilated. Each pupil shall be provided with not less than 225 cubic feet of space, . . . and the interior walls and ceilings shall be either painted or tinted some neutral color as gray, slate, buff or green. All school-rooms where pupils are seated for study shall be lighted from one side only, and the glass area shall not be less than one-sixth of the floor area, and the windows shall extend not less than four feet from the floor to at least one foot from the ceiling, all windows to be provided with roller or adjustable shades of neutral color, as blue, gray, slate, buff or green. Desks and desk seats shall preferably be adjustable, and at least twenty per cent. of all desks and seats in each room shall be so placed that the light shall fall over the left shoulders of the pupils. For left-handed pupils, desks and seats may be placed so as to permit the light to fall over the right shoulder."

Second, "Cloakrooms, well-lighted, warmed and ventilated, or sanitary lockers, shall be provided for each study school-room."

Third, "Ventilating heating stoves, furnaces and heaters of all kinds, shall be capable of maintaining a temperature of 70 degrees F. in zero weather and of maintaining a relative humidity of at least 40 per cent.; and said heaters of all kinds shall take air from outside the building, and, after heating, introduce it into the schoolroom at a point not less than five, nor more than seven feet from the floor, at a minimum rate of 30 cu. ft. per minute per pupil, regardless of outside atmospheric conditions; Provided,

that when direct-indirect steam heating is adopted, this provision as to height of entrance of hot air shall not apply. Halls, office rooms, laboratories and manual training rooms may have direct steam radiators, but direct steam heating is forbidden for study school-rooms, and direct-indirect steam heating is permitted. All school-rooms shall be provided with ventilating ducts of ample size to withdraw the air at least four times every hour, and said ducts and their openings shall be on the same side of the room with the hot air ducts."

Fourth, "Whenever, for any cause, the temperature of a school-room falls to 60 degrees F. or below, without the immediate prospect of the proper temperature, namely, not less than 70 degrees F. being attained, the teacher shall dismiss the school until the fault is corrected; and it shall also be the duty of all teachers to immediately send home any pupil who is perceptibly ill in any way, or who is unclean and emits offensive odors, or who is infested with lice or other vermin, and the truant officer shall arrest and prosecute parents or guardians who do not rid their children of vermin and bodily uncleanliness, when notified to so do."

Fifth, "All school-houses shall be especially cleaned and disinfected each year, before they are used for school purposes. The cleaning shall consist in, first, sweeping, then scrubbing the floors, washing the windows and all woodwork, including the wooden parts of seats and desks, and the disinfecting shall be done in accordance with the rules of the State Board of Health."

The committee is informed on good authority that this year Nebraska had a very satisfactory bill prepared for presentation, but it did not pass. Some of the spirit of the law is to be found in the following requirements, which are now a part of their State laws. In cities of the metropolitan class (100,000 or more population), and in cities of the first class (40,000 to 100,000), mention is made that "proper ventilation shall be provided." The words "proper ventilation" are not defined in any way, neither is there any statement defining the persons involved nor the penalty to be inflicted for non-fulfilment of requirement. The laws are satisfactory concerning safety from fires, over-crowding, etc., but touch lightly upon pure air.

The health program recently proposed by the Nebraska Asso-

ciation of School Principals and Superintendents has a good ring to it. They request:

First, compulsory ventilating heating plants.

Second, compulsory cleaning and disinfecting of school-houses at least twice each year.

Third, compulsory submission of all school-house plans to the State Architect for approval.

Fourth, compulsory medical inspection of school children.

Fifth, compulsory medical inspection of all school teachers.

Let us hope that the good work in Nebraska will keep up.

In Wisconsin a Factory Ventilation Bill was introduced this spring which reads in part as follows: "In factories, mills, workshops, mercantile or mechanical establishments, the windows shall be so arranged that they will permit of the circulation of fresh air from the outside of the building at all times, and shall be so constructed as to prevent direct drafts from striking the employees working therein. Where the circulation of fresh air cannot satisfactorily be secured through an arrangement of the windows, any system of ventilation that will keep the air therein free from substances and qualities injurious to the health or comfort of the employees, either by fans, suction devices and the like, which shall be approved by the Bureau of Labor and Industrial Statistics, may be installed. Every factory inspector and every assistant factory inspector, charged with the inspection of factories, mills, workshops, mercantile or mechanical establishments, shall investigate the system of ventilation in every plant inspected, and wherever same is not found to comply with the provisions of this act, notice thereof shall be given to the owner or owners thereof, or to the officer or officers, if said factories, mills, workshops, mercantile or mechanical establishments be corporations."

Kansas recently passed a compulsory ventilation law for theatres, picture shows, churches and other public buildings.

"Section 4. It shall be unlawful for the owner, proprietors or lessee to operate any theatre, picture show or place of amusement in any structure, room or place in the State of Kansas, which structure, room or place is capable of containing fifty or more persons, unless the system of ventilation is capable of supplying at least 30 cu. ft. of fresh air per minute per person therein."

"Section 5. All structures, rooms or places used for the purpose mentioned in section 4 of this act, having less than 500 cu. ft. of air space for each person, and all rooms having less than 2,000 cu. ft. of air space for each person in which the outside window and door area used for ventilation is less than one-eighth of the floor area, shall be provided with a draught fan or other artificial means of ventilation, installed so as to force the stagnant air outward from said structure, room or place. In the end of the room opposite said fan an inlet ventilator shall be provided of sufficient size to admit the required amount of fresh air as provided in section 4 of this act. All booths used for moving picture machines shall be made of galvanized sheet iron of not less than 20 B.W. gage, or ¼ inch hard asbestos board, securely riveted or bolted to angle iron frame (of not less than 1 x 1 x ¼ in. angle iron, properly braced), or equivalent fire resisting material. A not less than 6 inch diameter ventilating pipe shall be used as an exhaust for the hot air generated in operating the machine. All electric wiring shall be in accordance with the National Electrical Code. Inspection is to be made at least once every six months, and failure to comply with the law makes the proprietor, lessee or manager subject to a fine of $10.00 per day for such failure."

On March 6th North Dakota adopted a Compulsory Ventilation law applying principally to schools and assembly rooms. The following are extracts:

"Section 1. No building which is designed to be used, in whole or in part, as a public-school building, shall be erected until a copy of the plans thereof has been submitted to the State Superintendent of Public Instruction, who for the purposes of carrying out the provisions of this act is hereby designated as inspector of said public-school building plans and specifications, by the person causing its erection by the architect thereof; such plans shall include the method of ventilation provided therefor, and a copy of the specifications therefor."

"Section 2. Such plans and specifications shall show in detail the ventilation, heating and lighting of such building. The State Superintendent of Public Instruction shall not approve any plans for the erection of any school building or addition thereto unless the same shall provide at least 12 sq. ft. of floor space and 200 cu. ft. of air space for each pupil to be accommodated in each

study or recitation room therein. . . . All ceilings shall be at least 12 ft. in height. . . . No such plans shall be approved by him unless provision is made therein for assuring at least 30 cu. ft. of pure air every minute per pupil and warmed to maintain an average temperature of 70 degrees F. during the coldest weather, and the facilities for exhausting the foul or vitiated air therein shall be positive and independent of atmospheric changes. No tax voted by a district meeting or other competent authority in any such city, village, or school district, exceeding the sum of $2,000, shall be levied by the trustees until the State Superintendent of Public Instruction shall certify that the plans and specifications for the same comply with the provisions of this act. All school houses for which plans and detailed specifications shall be filed and approved, as required by this act, shall have halls, doors, stairways, seats, passageways and aisles, and all lighting and heating appliances and apparatus arranged to facilitate egress in case of fire or accident and to afford the requisite and proper accommodations for public protection in such cases."

"Section 3. No toilet room shall be constructed in any public school building unless same has outside ventilation and windows permitting free access of air and light. The provisions of this act shall be enforced by the State Superintendent of Public Instruction or some person designated by him for that purpose."

"Section 5. No wooden flue or air duct for heating or ventilating purposes shall be placed in any building which is subject to the provisions of this act, and no pipe for conveying hot air or steam in such building shall be placed or remain within one inch of any woodwork, unless protected by suitable guards or casing of incombustible material."

Respectfully submitted,

JAMES D. HOFFMAN, General Chairman.

DISCUSSION.

Prof. Hoffman: I wish to say that the committee has in mind for the next half of this year, with the assistance of the members of the Society, to work out if possible an ideal law, with blanks and brackets suitably arranged, such that we can refer to it as a standard law for compulsory ventilation and heating. Just

how nearly this will succeed by the next meeting of course is a question, but that is the aim, at least.

Mr. Weinshank: Referring to the report of Professor Hoffman, I wish to make the following addition to the report from Indiana:

The law submitted to the Indiana Legislature by Dr. Hurty was complete from an engineering and a sanitary standpoint. Before this bill was introduced in the Legislature I had tried to get the Society to outline an ideal law such as would apply throughout the United States. This I could not get in time. Dr. Hurty submitted to the Legislature the best bill he could draw up, and, in fact, it was approved by all who read the bill before same was passed.

While the Legislature was in session I was away and could not give the matter much attention. Dr. Hurty was also busy with other matters, and could not spend as much of his time as was necessary before the committees. Some manufacturers for some reason or other went before the committee of the Legislature and objected to some portions of the bill, and urged some changes.

The most important change was the omission of one word, "only." In the proposed law it was stated that "no school-house shall be heated with direct radiation only." The omission of the word "only" has caused considerable trouble in a number of cases where blast heating could not be installed.

The law requires 30 cu. ft. of air per pupil; this must be supplied to the room, and since with the direct-indirect system alone this amount of air could not be obtained, there are some question raised whether or not the law will stand. However, we in Indiana are satisfied with what we have secured so far and hope at the next session of the Legislature to get the rest of what we intended.

Referring to the Nebraska law mentioned by Professor Hoffman, I will state that there is in existence in Indiana, an "Inspection Law" passed two years ago. Under this law all the children in the school houses in Indiana are inspected every sixty days, or as often as the inspectors or doctors can get to them. In fact the law as passed in Nebraska has been enforced in Indiana for over two years.

I strongly endorse Professor Hoffman's recommendation, namely, that this Society appoint a committee whose duty shall

be to draw up a practical and an ideal law for compulsory ventilation. This could be used by all States, or by engineers in different States, as a model to enact so much as possible in various States.

Most of the Legislatures consist of lawyers, farmers, and business men, who are not in a position to distinguish between a good and a bad law for compulsory ventilation, but if the legislators should know that the bill put before them is drawn up by competent heating engineers, it would have more weight, more influence and possibly would pass more readily than if it came from some local politician.

Mr. Tait: Did I understand Mr. Weinshank to say that in Indiana they actually favored radiation and cut out direct-indirect altogether?

Mr. Weinshank: No; I stated that the law reads that no school house shall be heated by direct radiation. We had it that no school shall be heated by direct radiation only. The word "only" is left out.

A Member: As I understand it then, you can use direct and direct-indirect or direct and fan?

Mr. Weinshank: You cannot use direct and fan.

Mr. Bronaugh: In regard to the Indiana State Law providing for the exact location of vertical ducts for the introduction of air into the room, it does not seem that the introduction of air into the room necessarily constitutes ventilation, or that it is just right to prescribe a minimum of five or a maximum of seven feet from the floor line to determine the zone for the introduction of air.

Mr. Weinshank: It was originally seven and I think they make it five and seven.

Mr. Bronaugh: It would seem, from the results that we have obtained from some experiments here in Chicago, that we are on the wrong track when we prescribe where we are to introduce the air. A prescribed amount of air introduced into a room will not necessarily mean that the room is ventilated. I think that Mr. Weinshank's suggestion in regard to getting up an ideal ventilation law would be right, but we want to work on determining the point for the introduction of the air.

Mr. Davis: There is a law in the State of Ohio regarding school heating, one of the provisions of which is that direct-indirect radiation shall not be used in a school building.

Mr. Armagnac: The Ohio Legislature has recently passed a bill covering the sanitation, plumbing and ventilation of theatres in Ohio, and I had a letter from the Attorney General of Ohio the other day saying it was passed and would be distributed within two weeks. It provides for 1,200 feet of fresh air per occupant of every theatre.

President Bolton: Nothing could more clearly illustrate the value of the work of the Society in this direction than what has been brought out at this meeting. Clearly we are on the threshold of the greatest development in the art of ventilation that this country has ever seen, and much of it has to come about through legislation. This is evidently the course now being developed all over the United States. Whether there can ever be a law covering the whole country, with its varied conditions, is a problem which our special committee is to try to solve; but I think the chairmen of the several sub-committees ought to be congratulated on having gotten so earnestly to work, and on having gathered information that is evidently leading to a point where they may be able to produce a standard form for such legislation.

Mr. Lewis: I would like to obtain some information from Mr. Weinshank and Professor Hoffman, if possible, regarding the strenuosity with which the letter of that Indiana law is carried out. For instance, I happened to be called in on a school house a few days ago in which they had an adequate steam heating plant, but required a ventilating plant. The natural and proper thing to do with that building for ventilation is to put in a fan and tempering coil, and let the present direct steam heating system remain. Will I be in trouble with the new law if I pursue this course?

Mr. Weinshank: I failed to state that the Indiana law is the only one in existence in which there is a punishment clause:

"Trustees, directors and school boards that permit the installation of a heating system not in compliance with the law are subject to fine, imprisonment, or both.

"Contractors installing a contract not in accordance with the law cannot collect their bill."

President Bolton: Is the engineer also included in that, Mr. Weinshank?

Mr. Weinshank: He is if he does free engineering; however,

in order to enforce this law the officials are somewhat lenient at the start in order not to make the law obnoxious.

Mr. William Mackay: In the east our laws generally do not apply to old buildings at all. Hence there can be reconstruction and changes in local heating plants in school houses erected previous to the enactment of the law. The law is not retroactive.

Mr. Johnson: The law of Indiana as it is worded is very unsatisfactory. It starts out by saying that we must furnish thirty cubic feet of air per minute per pupil; and further along it states that the air must be exhausted four times per hour, which is one-half the amount required.

Mr. Davis: I move that the report be received and placed on file.

The motion was seconded, put to a vote and carried.

Prof. Hoffman: May I ask the members of the Society to furnish the committee with all information that comes to hand in regard to the new laws that are proposed, laws pending or laws passed, so that the committee may keep well informed? I find it is very difficult for us to keep in touch with everything that is new in this line.

President Bolton: That request I am sure the Secretary will transmit at the first opportunity to all our members.

The Committee on Standards reports progress.

The Committee on Tests reports progress.

We pass to the Committee on Heating Guarantees. We call on Mr. Mackay for a brief statement of progress.

Mr. Mackay: Our committee was appointed by resolution to report at the annual meeting, and we have no regularly prepared report at this time. So far all of the work has been done by correspondence. The letters are direct and to the point, and I would like to read several replies for the benefit of the members. I will read them without the names.

(Reads letters.)

I think that the members of the committee are rather unanimous in the thought that the engineer should be given a free hand in design, and that he should be held responsible for any errors or defects in his work. That is my own personal view as well as that of the other members of the committee.

President Bolton: The report being one of progress only, we need no resolution upon it.

The Committee on Schoolroom Ventilation. I believe we have a letter, Mr. Secretary.

Secretary Macon: Yes, sir; from Mr. Frank Irving Cooper. The letter is to the effect that he has been hampered in this work by the illness of Dr. Gulick. Those of you who were present at the annual meeting will recall that in response to the request of Dr. Gulick, succeeding his speech before the Society, the Committee on the Ventilation of Schoolrooms was appointed to work with a committee of the American School Hygiene Association. The illness of Dr. Gulick was somewhat unfortunate, as he was outlining a very definite line of investigation into schoolroom conditions.

President Bolton: That is practically a report of progress. We pass on to the report of the Committee on Air Leakage and Ventilation of the Closed Room, which also reports progress. That again is a committee which, as you will notice by the list, it has been thought well to subdivide; and we may hope for very good work from them, owing to a combined study of the circumstances in different parts of the country covered by the committee's membership.

Secretary Macon: The Committee on Revision of Constitution is not to report until the annual meeting.

President Bolton: This closes our committee work, and enables us to proceed to the interesting paper on "Free Engineering," which is not printed, but will be presented by Professor Hoffman, for the authors, Messrs. Perry West and George W. Knight.

The paper was read by Professor Hoffman and discussed by President Bolton and Messrs. Bronaugh, Davis, Mackay and Hoffman.

President Bolton: The next subject is topical discussion No. 1: "Operation and Care of Heating and Ventilating Apparatus." I will call upon Mr. Mackay to discuss that subject.

The subject was discussed by Messrs. Mackay, Allen, Patterson, Weinshank, Tait and President Bolton.

President Bolton: The next topical discussion is No. 2: "Reluctance to Divulge Alleged Secrets in Relation to Engineering Progress."

The question was discussed by Messrs. Macon, Mackay, Monett, Hale and Weinshank.

On motion the meeting adjourned till 2.00 P. M.

First Day—Afternoon Session.

(Thursday, July 6, 1911.)

The meeting was called to order at 2.30 P. M. by President Bolton.

President Bolton: During the reading and discussion of the next paper the chair will be taken by Professor Allen in order to give the President a chance to get on the floor and take part in the discussion of his own paper.

The reading of the paper on "Some Phases of Smoke Prevention," by Mr. Paul P. Bird, is the first on our calendar.

(Professor Allen takes the chair.)

The paper was read by Mr. Bird.

Chairman Allen: Mr. Bird's paper is closely allied to the President's address this morning and the two may be discussed together.

The paper and the address were discussed by President Bolton and Messrs. Busey, Hoffman and Bird.

Chairman Allen: If there is no further discussion of Mr. Bird's or President Bolton's paper we will proceed with Mr. Busey's paper on the "New Basis for Rating House Heating Boilers and Furnaces."

(President Bolton resumes the chair.)

Mr. Busey read the paper, which was discussed by Messrs. Weinshank, Hoffman, Allen, Mackay, Sterrett and President Bolton.

President Bolton: Without closing this discussion we might take up the next question, which follows it immediately and seems to be directly connected with it: "Relative Efficiency of Vertical and Horizontal Surfaces in Heaters for Heat Transmission." That might perhaps be extended to include fire on indirect surfaces. Is there any further discussion?

We have another paper which bears very much on the same subject, "Tests of Warm Air Furnace Piping," by Mr. A. W. Glessner, a non-member.

The paper was read by Mr. Glessner and briefly discussed by Messrs. Hoffman and Allen.

President Bolton: Is there any further discussion? If not, we will take up the topical discussion, which is also associated with

this general subject: "Justifiable Public Service of the Heating Engineer in Minimizing Smoke Production."

There was no discussion on this topic.

Mr. Capron: I wish to make a motion that a vote of thanks be extended by this association to Messrs. Bird, Busey and Glessner for their very interesting papers.

The motion was seconded and carried.

President Bolton: We have now the last topical discussion here, which seems one of considerable interest: "Co-operation of Tuberculosis Fighter and the Ventilating Engineer."

There was no discussion on this topic.

On motion the meeting adjourned until ten o'clock on Friday morning.

Second Day—Morning Session.

(Friday Morning, July 7, 1911.)

The meeting was called to order at 10.15 A. M.

President Bolton: The first subject is a paper by Mr. S. R. Lewis, "Heating and Ventilating High School Buildings in Decatur, Illinois."

The paper was read by Mr. Lewis and discussed by President Bolton and Messrs. Hoffman, Burdick, Collamore, Cones, Gifford and Hayward.

President Bolton: If there is no further discussion of this subject we will proceed to our next paper. Prior to that the Chair would like to make an announcement on behalf of our good friend Mr. Weinshank, who had to leave town early this morning and was unable to get a hearing yesterday. In February last he attended a meeting of the Institution of Heating and Ventilating Engineers in London, and was very courteously received and entertained by that body at their annual meeting, which took place on the 14th of February. The Institution commissioned Mr. Weinshank to convey to us their greetings and expressions of good will and a desire for co-operation with our Society. The expression, he tells me, was made by several of the members, that an interchange of the publications of both Societies might be effected without too great cost, which would be of mutual benefit. Under those circumstances Mr. Weinshank desired the Chair

to make this announcement and suggest that a short message of greeting should be sent from this body to the Institution of Heating and Ventilating Engineers, assembled this week in Chester, England, at their semi-annual gathering; and I should be glad to entertain a motion to that effect.

Mr. Mackay: Mr. President, I would move that a cable message be sent to extend our greetings to the English society, and to thank them for their cordial recognition, through Mr. Weinshank.

The motion was seconded and carried.

President Bolton: The next paper is by Mr. D. M. Quay on the "Ventilation of the Macy Store, New York." In the absence of Mr. Quay the Secretary will present the subject.

The paper was read in abstract by Secretary Macon and discussed by President Bolton and Messrs. Davis, Soule and Allen.

President Bolton: We will now pass to the reading of a paper, that comes very close to this subject, on "Street Car Ventilation," by Mr. W. Thorn.

The paper was read by Mr. Mackay and discussed by President Bolton, Natkin, Kirk, Lewis and Soule.

Mr. Mackay: Before passing away from this paper of Mr. Thorn's I would like to move that the thanks of the Society be tendered Mr. Thorn, who is a non-member, for the contribution of this paper.

The motion was seconded and carried.

President Bolton: Topical discussion No. 3 is one of considerable interest: "The Amount of Solid Material, Dust and Dirt Extracted by Air Washing Apparatus in Various Cities, say per Million Cubic Feet of Air Treated."

The topic was discussed by Messrs. Thomas and Natkin.

President Bolton: The next topical discussion is "Superheated Steam in Long Steam Heating Mains."

I was not aware that this question would come up or I would have described the results of some tests made by Kellogg & Company on the loss of superheat in very long runs of piping in the Wilkesbarre district. At a future date I may get the investigator to bring them before the Society.

There being no discussion on this subject the next topic is one which was referred to this meeting from the convention, No. 4, "So-called Superiority of Exhaust Steam Heating Over Live

Steam Heating." I observe the use of the word "so-called," so I presume our Secretary has no hesitation in putting it down in that form. I will ask Professor Hoffman to say a few words on the subject.

The question was discussed by Messrs. Hoffman, Mackay, Gifford, Allen, Hale, Davis, Capron, Small.

President Bolton: If there is no further discussion, we may take up topic, "Late Data on the Air Cooling Capabilities of the Air Washer"; and also "The Future of the Fractional Radiator Valve."

If no one wishes to discuss these we may bring up these last questions, Nos. 5 and 6, or else leave them to the next annual meeting. Question No. 5 is "Desirability of a Positive Supply of Air in Testing Furnaces."

The topic was discussed by Messrs. Mackay, Busey and Colbert.

President Bolton: We pass to No. 6, "The Importance of Vacuum Cleaning to the Ventilating Engineer."

It is interesting to see how our profession is reaching out in such directions as this subject indicates. I recently received a report upon an examination of a vacuum cleaning device, which brings that form of appliance directly within the purview of heating engineers. It is a recent device by which a vacuum is produced by a steam jet, the pressure being raised by a gas fire, which is also used to dry or burn the dust caught by the apparatus. Such a combination indicates that vacuum cleaning has come within the scope of the work of heating and ventilating engineers.

The topic was discussed by Messrs. Allen, Mackay and Colbert.

There was no discussion of the next topic.

President Bolton: We will consider the next topical discussion: "The Value of Temperature Regulators for Relatively Small Residence Heating."

No discussion followed.

Mr. Mackay: Before we adjourn I would like to move a hearty vote of thanks from this association to the Illinois Chapter for the entertainment which they have provided and are providing for our comfort while in Chicago.

President Bolton: The second will come from every member present.

It is duly moved and seconded that a vote of thanks be extended to the Illinois Chapter and their President for their courtesy and attention to our Society at this convention. All those in favor of the same will please say aye; contrary no. It is unanimously carried.

Secretary Macon: I want to announce before the meeting closes that less than a month ago we elected by ballot twenty-six members, whose names follow:

P. A. Bates	Member.
W. H. Chenoweth, Jr.	"
S. Franklin Gardner	"
Joseph Graham	"
G. T. Hill	"
E. C. Hinkle	"
P. A. Hoffman	"
C. R. Honiball	"
Newton K. Howard	"
W. P. Klobukowski	"
J. I. Lyle	"
Floyd A. Miller	"
M. P. Miller	"
W. R. Murphy	"
D. E. Polglase	"
C. L. Reeder	"
Arthur Ritter	"
Hugh C. Russell	"
W. T. Smallman	"
Robert Thomson	"
Clarence W. Williams	"
Harry L. Williams	"
Warren G. Culbert	Associate
Joseph McCusker	"
C. H. Spiehler	"
E. J. Treat	"

On motion the meeting adjourned.

List of Members and Guests present at the semi-annual meeting, Chicago, Ill., July 6-8, 1911.

MEMBERS.

Allen, J. R.
Armagnac, A. S.
Bolton, R. P.
Boylston, John
Bradley, E. P.
Bronaugh, W. L.
Burdick, A. C.
Cameron, A. S.
Cameron, W. A.
Capron, E. F.
Chenoweth, W. H., Jr.
Collamore, Ralph
Cripps, A. G.
Davis, J. H.
Dugger, J. P.
Ellis, H. W.
Gifford, R. L.
Gifford, B. T.
Gordon, E. B., Jr.
Graves, W. B.
Hale, J. F.
Hayes, J. G.
Hayward, R. B.
Joannis, Harry de
Johnson, W. H.
Kirk, G. H.
Kitchen, J. H.
Lee, H. H.
Lewis, S. R.
Mackay, W. M.
Macon, W. W.
Mallory, H. C.
McGuire, F. W.
Mehring, George
Murphy, E. N.
Natkin, Benj.
Newport, C. F.
Patterson, N. L.
Ritchie, William
Schroth, A. H.
Scudder, W. M.
Small, J. D.
Soule, L. C.
Stackhouse, R. M.
Stannard, J. M.
Tait, G. M.
Tait, Thomas
Warsop, C. E.
Weinshank, Theo.
Widdicombe, R. A.

GUESTS.

Bailey, F. M.
Baker, H. W.
Berwin, L. M.
Bird, P. P.
Boylston, A. M.
Brady, B. W.
Busey, F. L.
Caldwell, A. H.
Carey, E. C.
Clark, A. T.
Colbert, W. F.
Collins, Emmons
Cones, Benj.
DeBerard, C. M.
Denison, C. H.
Duene, H. R.
Eddy, R. L.
Ehrlich, H.
Foster, C. K.
Glessner, A. W.
Goff, A. W.
Heg, J. E.
Hillman, R. W.
Kauffman, G. H.
Kuss, R. H.
Lamb, T. G.
Larsen, Victor
Leags, J.
Marell, H.
Martin, J. H., Jr.
Meehan, Joseph
McLelland, H. B.
Miller, H. A.
Monnett, O.
Moore, M. F.
Morley, J. P.
Nelson, Ben.
Orr, F. R.
Pursell, H. E.
Putland, H. R.
Reber, B. F.
Rood, O. G.
Rosenbach, R. G.
Schad, A. E.
Scheible, Albert
Sterrett, A. F.
Stern, Daniel
Stroudfoot, G. M.
Sugarman, E.
Thomas, R. H.
Thorn, W.
Tratman, E. E. R.
Van Inwagen, F.
von Rehm, D. E.
Whitelaw, F. S.
Wing, J. F.
Wood, G. W.
Wright, C. E.
Mrs. W. Adams
Mrs. R. Collamore
Miss D. Hayes
Mrs. H. de Joannis
Miss S. de Joannis
Mrs. G. H. Kirk
Mrs. G. M. Tait
Mrs. Thomas Tait
Mrs. Th. Weinshank
Miss A. Weinshank
Mrs. M. von Rehm

CCXLI.

THE OUTLOOK OF THE SOCIETY.

The President's Address.

REGINALD PELHAM BOLTON.

There are those who are content to steer their course along the stream of their occupation regarding only their main objective, but it would seem that something may always be gained by a widened outlook, and the man who, between the strokes of the oar, can find opportunity to gaze a little beyond the bounds of his path, may find incentives to effort and may gain new inspiration from the work of others.

The members of the American Society of Heating and Ventilating Engineers may apply with advantage such considerations to our activities, and, by some observation of subjects which are only apparently extraneous, may find that our Society's work covers a wider field than that to which it has been assumably restricted.

The art of heating is fundamental to human life; next to the possession of a supply of the primary elements of air and water, the means of securing heat is an absolute necessity for the maintenance of existence. This branch of science has been extended, and properly so, to include the kindred subject of ventilation, which is intimately associated with the health of a large part of our population. But there are further extensions of these two great matters which may appear to be appropriately connected with them, and could be included in the scope of our Society's interests.

The processes of heating and ventilating are both associated directly with the physical condition of the atmosphere, and therefore a study of any phase of science by which that great primal element is affected, would appear to be worthy of the consideration of heating and ventilating engineers.

We are directly interested in questions of combustion, of smoke and its abatement, of fuel and its economies, and have a keen interest in the kindred field of refrigeration, which is now applied directly to purposes of ventilation and even to processes of combustion. We are, or should be, the class of engineers most interested in the economics of fuel consumption and power production and transmission, in which the question of heat transference is the vital element.

Methods of drying various materials and desiccation of food products, with problems involved in moisture and dampness affecting buildings, are subjects with which the heating and ventilating engineer is qualified to deal by the nature of his study and training. Our line of work brings us into the realm of acoustics, and should particularly qualify us to deal with the subject of noises and of vibration.

But in addition, the variations of wind, of weather, of rainfall and such geographic features as affect the atmospheric envelope with which we have to deal, are subjects that come within our purview.

Following this line of thought, I shall venture to lay before you some results of an excursion into one of these fields of study, and invite your attention to the subject of probable effects upon the climatic surroundings of a great city, by the vast quantity of heat emanating from its industries and from the heating of its buildings.

The lowest range of temperatures which are to be expected in any locality are naturally those which must form the basis for the computations and estimates of the heating engineer, in making provision for the proportions of heating systems and piping, of heating apparatus, boilers and their smoke-stacks, all of which are, naturally, planned to meet the requirements with some degree of liberality in proportion.

The effect of such considerations is to provide appliances, the capacity of which is at least equal to, if not in excess of, the maximum requirements. It naturally becomes a question whether the appliances so installed can be utilized at other times with a reasonable degree of efficiency, or whether the provision of such proportions will not bring about a loss of economy during the prevalence of all higher temperatures than the basic condition adopted.

It is important, therefore, for the heating engineer to study the past records of temperatures in order to determine the maximum conditions of any locality. In New York City, fortunately for such enquirers, our local authorities maintain, under the direction of the venerable Dr. Daniel Draper, hourly records of every element of atmospheric vicissitude, extending over a long period of time, and recorded under conditions of precise regularity.

It was found on examination of these records that the occurrence of a temperature as low as, or lower than zero, has been of less frequency for many years, and since 1904 has not been

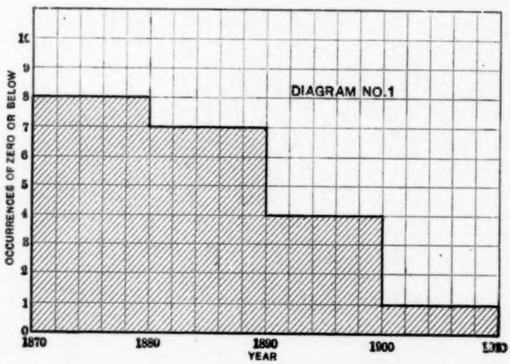


Diagram Showing Decreases in Occurrences of Zero Temperature and Below in New York City.

[Last occurrence, January 5, 1904.]

experienced at all. Further, that such occurrences are so infrequent and of so short a duration, that the provision for heating, under such conditions, might be provided by some excess or over capacity of apparatus, by which means much idle investment might be saved.

This leads to the question whether the practical elimination of "zero conditions" has been effected or brought about by any artificial means. Attention is naturally further directed by the prevailing shortage of water in the Metropolitan area, to the records of humidity and precipitation, and it appears that in this element of our atmospheric surroundings some change has also taken place. On the other hand, the growth of fuel consumption and the resultant heat emitted over the area of the Metropolis,

has been such that the question arises whether or not its volume has reached an extent capable of affecting atmospheric conditions.

Exact statistics of the consumption of fuel within the boundaries of the city have not been recorded for any great length of time, but sufficient indication may be gathered from those recorded during recent years to indicate that the increase in consumption has kept pace with the vast growth of the population.

CONSUMPTION OF FUEL IN THE CITY OF NEW YORK

The following details of the usage of coal in Greater New York are derived in part from the *Coal Trade Journal,* and in part from the public records:

The generation of power for transit purposes consumed in the year 1909	1,343,573 tons
The electrical lighting companies consumed in 1909	884,757 "

The production of gas involves the distillation of 918,000 tons of coal per annum, from which 450,000 tons of coke are derived, of which 188,000 tons are consumed by the gas companies, and 271,000 tons distributed and added to the domestic fuel consumed in the Greater City.

In addition to the fuel, 137 million gal. of oil are used for gas enrichment, or a total weight of	512,000 tons,
equivalent in heat value to coal of a weight of	768,000 "

From these products there was made in 1909, an output of thirty-six and one-half million thousands of cubic feet of gas, which was distributed and burned within the area of the Greater City.

The production and consumption of gas, therefore, is equivalent to the heat value of a total of 1,686,000 tons.

There are 50 breweries, consuming about 500,000 tons annually, and the fleets of harbor tugs and vessels are estimated to consume about 450,000 tons of bituminous coal.

There are 745 private power plants in industrial, hotel and business buildings consuming about 2,200,000 tons.

The domestic usage of fuel, in houses, stores and apartments, is by far the largest and best defined element, amounting to 6,380,000 tons.

Sundry other elements bring the present annual consumption to a total of approximately 16,932,000 net tons per annum.

A proportionate addition for the consumption in Jersey City and its vicinity, in which a population of some 340,000 persons is resident, would add 1,250,000 tons.

With the addition of the oil used in gas manufacture, the total equivalent in coal becomes 18,950,000 tons.

The consumption of fuel has grown 23 per cent. in five years, and its course is shown in Diagram 3, on which is also shown the growth of population of the Greater City, showing a nearly

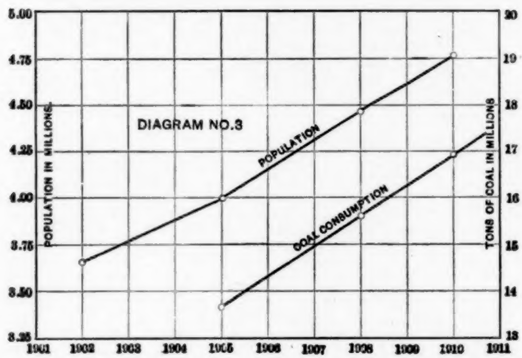


Diagram Showing Increase of Population and Fuel Consumption in New York City Since 1901.

parallel rate of increase, doubtless due to the large proportion of fuel which is directly utilized for domestic purposes.

THE HEAT EMITTED BY THE CITY

With these figures in hand, we can arrive at some estimation of the vast quantity of heat communicated to the incumbent atmosphere, particularly during the heating season.

From all the sources above described, there is cast up into the atmosphere a volume of heated gases, at an average temperature of fully 350 deg. F., probably eighteen times in weight that of the fuel consumed.

To the volcano of heated gases is added all the exhausted steam, and the products of combustion of gas, all mingling directly with the atmosphere, and in addition the radiant heat and heat conveyed by convection from all buildings, all frictional sources, and dissipation of energy.

The heat of condensed steam in power houses and that of all sewage is communicated to the waters within the area of the city, and is thus indirectly added to the heat-radiating effect.

A not inconsiderable item is that of the animal heat of the population of 5,000,000 persons, which, upon the basis of an average emission of 200 heat units per hour per individual, would amount to 24,000,000,000 per diem, equivalent to the heat value of 438,000 tons of coal per annum.

THE EFFECTS ABOVE THE CITY

The portion of the city in which the fuel consumption takes place is practically that included within an area of 130 square miles, comprised within an oval space shown on the accompanying map.

Within this area, during the winter heating season, about 80 per cent. of all the fuel, and about 60 per cent. of the oil is consumed. The average consumption of 85,830 tons per diem, upon the basis of an average temperature of 40 deg., leads to the extreme condition, when a zero temperature is approached, of a consumption of 214,560 tons per diem.

We may first consider the effects of the emission from the smoke flues and stacks of the gases derived from their combustion of this amount of fuel.

Assuming the emitted gases to be 18 times the weight of fuel burned, their daily volume would be 175,680,000,000 cubic feet, and if their average temperature be taken as 350 deg. F., the heat contained would be 614,500,000,000 heat units. Such a heated volume would add three and a half degrees to the temperature of the atmosphere, one-half mile in height, over the area of 130 square miles.

If to the volume of these gases of combustion, we add the radiant heat and that imparted by convection from all sources to which reference has been made, we find a total exceeding 4,000,000,000,000 heat units per 24 hrs., which may be capable of increasing by a similar amount the temperature of a volume of air seven times greater than the foregoing, or would raise the temperature 4.94 deg. F. over the entire area of the Greater City, 326 square miles, to a height of a mile.

It would seem, therefore, that the first premise as to the effect

MAP OF THE 130 SQ. MI. OF THE METROPOLITAN AREA OF NEW YORK, THE HEAT DEVELOPMENT OF WHICH IS CONSIDERED.

of the heat emitted by the city in modifying the lowest temperatures of the heating season, is substantiated.

EFFECTS UPON PRECIPITATION

That this great emission of heat is also capable of producing some effect upon rainfall appears from the conditions disclosed by the records of precipitation.

The mean annual rainfall of the City of New York is 44.6 in., an average which, up to the year 1903, was fairly maintained, the average for 25 yr. prior to that date being nearly 45

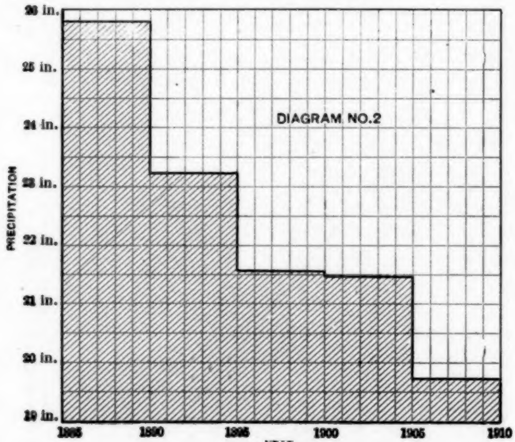


Diagram Showing Decrease in Precipitation During Winter Months Since 1884.

in. Since 1903, however, the mean precipitation has fallen to 40.17, and the highest annual rainfall in that period, 1907, was only 45.48.

At the same time the number of cloudless days has considerably increased. Between the years 1889 and 1903, the highest number of such occurrences was 96, but since 1903 the highest has risen to 114, and the average for seven years has been 101.

These are indications of a growing condition of dryness which appear to accompany a decrease in annual precipitation, which in 1910 fell to the unusually low rate of 33.72 in. Examination of the precipitation during the heating season shows that there has been a progressive decrease during the past 20 yr.,

and since the winter rains are those which are least subject to evaporation, their reduction is likely to be productive of the condition of dryness from which New York is at present suffering.

Assuming that the large volume of heat already described should be added to the incumbent atmosphere over the area of the city, or 326 square miles for each degree added, the increased temperature of the air would add about 3½ per cent. to the moisture-absorbing capacity of the atmosphere. It is evident that this great volume of heated air would, in the absence of wind, rise as do the gases emitted from the mouth of a volcano, and reaching a certain height, would spread and fall as they were gradually cooled by the cold blanket of super-incumbent air or moisture-laden clouds. The effect would thus radiate over a very considerable area, and would be productive of just such a variation of the conditions of humidity in the city and its surrounding district as appears from the records to have been gradually developing.

So far as the rise of temperature is concerned, no other than beneficial results can be attributed to the dissipation of this vast amount of heat, but if the effect extends, as it must extend, into the absorption of moisture by the air which would otherwise have been deposited upon the area below it, then we shall find, in a reduction of winter rainfall over this area, a result which may have reached an appreciable point at the present time, and which, in the course of time, by the growth of the interference with nature, may become disastrous.

That such an effect is now going on, would appear reasonable from the premises. The total heat emitted would raise the moisture-absorbing capacity of an envelope of air a mile high over an area of three hundred and twenty-six square miles about 7 1-3 per cent.

Let us assume that the usual conditions preceding a rainfall are in progress: A gathering amount of humidity in the superincumbent atmosphere has taken place, and a degree of saturation has been reached, of, say, 99 per cent., the temperature of the air being 42 deg. F. At the approach of any cooler wind or other layer of air, the temperature would fall, and upon reaching 40 deg., a condition of complete saturation would be reached and rain would commence. But meantime, the heat emitted by the city below is being continuously trans-

mitted to, or radiated through the atmosphere below, the rain clouds, and notwithstanding the fall in temperature of the superincumbent layers, the rising column of heat has the power of increasing the absorbing capacity of the layer below, or of retarding the fall in temperature of the saturated air, so that the dew point is not reached.

Under these circumstances, rain will not fall, though the atmosphere, for some distance above the ground, may be highly saturated, in which form it will remain as a fog.

The figures cited indicate that the total heat emitted by the city in average winter temperature of 40 deg. Fahrenheit would add to the temperature 2 deg. over the area of the Greater City, 326 square miles, to a height of one mile; and would produce the effect of increasing the capacity for saturation of the mass of 48,000,000,000,000 cu. ft. by a total of 1,440,000,000 lb. of water—equivalent to about 0.03 in. of rain over the entire area of the city.

If these conclusions as to the association of the mechanical dissipation of heat with the vicissitudes of temperature and humidity in the surrounding atmosphere should be well based, then we must look forward to an increasing degree of artificial interference with the course of nature, as the population and its fuel consumption grow on parallel lines.

It is worth while to observe that the coal consumption of the City of New York is by no means excessive compared with the per capita rate throughout the country. The destruction of fuel in this country has reached colossal figures, exceeding at present five hundred and fifty millions of tons, or a per capita rate of about 6 tons as against about 4 tons in the Metropolis.

All such considerations as have been here presented lead to the conclusion that this source of human wealth and comfort should not be unnecessarily wasted. As it is at the present time, the majority of domestic heating is effected at a very low percentage of efficiency. We must look forward to better methods for the production of heat, as well as of power, especially in great cities, probably by greater concentration in central heating plants, in place of the wasteful processes of domestic heating and power.

To devote earnest attention to all means which will be productive of desired effects under the most economic conditions,

to reduce useless and unnecessary wastages, to advance the great art which involves such immense possibilities of interference with the latent forces of nature, is not only the privilege, but the duty of every engineer, and particularly of every heating and ventilating engineer.

DISCUSSION.

For discussion see paper on "Smoke Prevention," by Paul P. Bird.

CCXLII.

SMOKE PREVENTION.

BY PAUL P. BIRD.*

You have asked me to address you on a subject that is, in my opinion, of far reaching and increasing importance to all communities where soft coal is used. In approaching this subject, I desire to call your attention to the fact that it is the work of the engineer, the heating and power engineer, that has brought into being the smoke nuisance, and that it is the duty of the engineer to give study to this problem and to put into practice means for its abatement. Broadly, the engineering profession is not an old one. It is only within the last sixty years that coal has come into general use for producing heat and power. During this period, which has been called "the epoch of manufactured power," wonderful achievements have been made, and the accomplishments of the engineer have worked a revolution in the lives of humanity. The heating and ventilating engineer has worked side by side with the steam and electrical engineer. In this relatively brief period, the use of coal for producing power and heat has advanced so rapidly that in 1910 the United States alone produced about 480,000,000 tons of coal, while at the beginning of this period only about 7,000,000 tons of coal were mined each year. About 83 per cent. of last year's coal production was bituminous.

This general use of coal as a fuel has brought with it the so-called smoke nuisance. In the eastern part of the United States, where hard coal is chiefly used, the products of combustion have not been offensive and communities burning this fuel have not been bothered by smoke. However, in all parts of America where soft coal is used, more or less smoke is made and more or less bother is imposed upon the people by reason of the smoke.

As one leaves New York and travels westward, the further he

* Non-member; Chicago, Ill.

goes, the more trouble he finds that the cities are having with smoke, and that it is in the cities, rather than in the small towns, that the smoke nuisance gives the most trouble, where it is of great importance to reduce it to a minimum. A single plant on the prairie or in a small country town may bother no one, but when dozens, hundreds or thousands of soft coal burning plants are grouped together in a city, then the smoke becomes a great civic problem and one that warrants the study and attention of the best engineers. In the open country a man may make all the smoke he chooses and no one complains, but when he operates a plant in a city, where there are thousands of people who must breathe the air which he pollutes, then it becomes his civic duty to so conduct his business and burn his coal that a minimum of smoke may be made with a minimum of bother to his neighbor. This is also true of steam railroads. The locomotive pulling a train across the open country may make great volumes of smoke and not harm any one or cause enough air pollution to damage property or life, but when this same locomotive runs through a town or city, where the buildings and homes are crowded together on either side of the right of way, then it becomes the duty of the railroad company to operate its locomotives with a minimum of smoke and damage to the city.

The use of coal for manufacturing power and heat, as already described, has been the means of bringing about a new epoch in the history of the world. It has been the most remarkable era in the annals of civilization. If the wheels of industry would necessarily stop when the smoke stopped, and if we would have to abandon the present methods of heating our buildings, then there would be no question but that the making of smoke must necessarily continue. However, if it is possible to burn this coal and to produce this power and heat without smoke at all, or with the production of less smoke than formerly, then it should be done. The individual or the corporation who burns coal should see to it, as a civic duty, that this is done, and unquestionably the city governments, where the smoke is the greatest nuisance, have a perfect right to insist that every effort be made toward this end.

About the middle of the period of sixty years, already referred to, the City of Chicago passed its first smoke ordinance. During the first twenty of the thirty years since the first anti-

smoke laws were made, but little was accomplished, but during the last ten years a great deal has been done, and Chicago is to-day second to no other city in America in the intelligent fight that is being made to prevent smoke from soft coal. Comparing Chicago, plant by plant, and stack by stack, with all other cities in America using soft coal, it is found that Chicago is by far the cleanest of all.

The author was the head of the Department of Smoke Inspection of the City of Chicago from September, 1907, to April, 1911, and a very brief outline of the work of that department will be given:

Shortly after Mayor Fred A. Busse was elected, in the spring of 1907, he appointed a committee of eight citizens to advise him about Chicago's smoke problem, and to help him decide on the policies and plans to be followed by the Smoke Inspector. The Mayor and the Commission gave the subject a great deal of study during the early months of 1907. They believed that more permanent progress would be made if the Smoke Inspector's office was so organized and administered that a citizen could receive more assistance than formerly from the city in his efforts to prevent smoke. They believed that the city's department should make a detailed study of the smoke problem, and not only should complaint issue to a citizen who allowed his plant to smoke, but he should be told what he should do to stop the smoke. It was also thought that a citizen who showed a disposition to co-operate with the city department should be given sufficient time to make the necessary alterations in his plant, but if he refused to do anything after he had been shown what to do, then suits should be started and fines imposed until he yielded and stopped the smoke. These general policies of co-operation between citizen and city department formed the foundation upon which the new department was built. As a result a new smoke ordinance was passed by the City Council on July 8th, 1907. The new ordinance, embodying the Mayor's and the Commission's ideas, created the present Department of Smoke Inspection and took the work of smoke inspection away from the Boiler Department. The ordinance provided that the head of the new Department, the Smoke Inspector, should be appointed by the Mayor and that all other members of the Department should come under the civil service law.

When the Department began its work in the fall of 1907 and undertook to enforce Section 14 of the smoke ordinance, which provided that the Smoke Inspector issue permits for all new steam plants and for the reconstruction of old plants, it undertook a class of work that had never been done before in Chicago or in any other city. This is probably the most important work done by the department. The average life of a boiler plant is relatively short, and a tabulation of the permits issued during the last three years shows that by the time the department has been in operation fifteen years practically every boiler in the city will come under this provision of the ordinance and be passed upon by the Smoke Inspection Department. In other words, by 1922 the details of every steam plant in the city will have been approved by the department with special reference to the prevention of smoke. This will mean a great deal. A large part of the smoke made by stationary boiler plants, without question, could be avoided if the plants were properly constructed.

There are three things which determine to what extent a boiler plant will smoke:

First, the kind of fuel to be used.

Second, the care to be exerted by the fireman.

Third, the character of the equipment for burning the fuel.

The power and heat for Chicago will always come from Illinois or Indiana soft coal. This is due to the location of the city relative to the coal mines and, although the methods of using this coal may be changed in the future, there is no question but what the local coal will continue to be the chief fuel. Therefore, the Smoke Department has no control over the first of these three things, which determine the smoke making characteristics of a plant.

The department can influence to some extent the care exerted by the firemen. When a plant through carelessness of this sort throws out objectionable smoke in violation of the law, the city can impose a fine upon the plant owner, and in this way exert an indirect influence on the fireman. So much has been said about careless firing that the public often loses sight of the fact that there are other features to be considered, and wrongly attributes all smoke to carelessness. In a great many of the plants in Chicago to-day it is probable that more care is required on the part of the fireman, in order to prevent smoke, than can reason-

ably be expected from men of this class. These plants are often located in dark, poorly ventilated basements, hot almost beyond human endurance, with only a very limited amount of space provided for operating the furnaces, and the general appearance and arrangement of the plant such that it can hardly be associated with care of any sort. In these plants it is such a task to merely keep up the steam pressure that no extra work is likely to be done for the sole purpose of preventing smoke.

The third feature, the equipment, is the only one over which the city has any direct control. If smokelessness is to be brought about, the general standard of the equipment must be such as will make up for the natural conditions of fuel, and allow for at least pardonable carelessness. Past experience has proven that unless detailed attention is paid to the equipment, plans will be installed in which western bituminous coal cannot be burned without smoke, even when extreme care is used. Such poor installations are not made wilfully by anyone who wants to make smoke and violate the city ordinances, but the mistakes are made through ignorance and because boilers and furnaces are installed without regard to the particular conditions that exist in Chicago. A boiler plant that would operate very satisfactorily in the eastern states with anthracite or the better grades of bituminous, will smoke very badly in this district when using western coal. Further, it is only within recent years that engineers have given careful study to the details of boiler plants with the idea of smoke prevention. When boilers and furnaces are installed according to well-established standards, which for the most part have been developed in the East, the result is most unsatisfactory from a smoke prevention standpoint. In Chicago, where every conceivable industry is carried on, and where the most diversified classes of smoke-making plants have been permitted to grow with no thought or provision for avoiding smoke, the suppression of smoke is a task requiring time, patience, firmness and a fund of knowledge and experience capable of solving the various problems submitted.

When the present department took up the work a great deal of Chicago smoke was due to poor equipment, and reconstruction work was the first necessity to stop smoke in plants of this character.

The general policy adopted was to determine by inspection whether or not the individual plant was capable of being operated smokelessly with average care. In case it was found that the plant was properly built and could be run without making smoke, provided the engineers and firemen were careful, then, if the smoke continued, suits were started and fines imposed in order to bring about such operation. However, when a plant was found to be improperly designed and built and that it was not possible for those in charge of the plant to run it without making smoke, then sufficient time was given to the owners to undertake proper reconstruction. During the early months of the work great difficulty was experienced in persuading the plant owners to spend money to fix up their plants. These men felt that as their plants had run for a number of years, accomplishing the purpose for which they were intended, they could not see wherein they were defective, and in their opinion the smoke was not sufficient for complaint, and their plants were not smoking more than many others in the city. These objections have gradually disappeared. The department, during the last year or so, has had relatively little trouble in persuading people to spend money for this purpose. Fortunately for the anti-smoke campaign, existing plants are being reconstructed continually because of the natural demands made upon them. Either more power is required, or old boilers have to be replaced with new ones. These were the first reconstructions that were supervised by the Department of Smoke Inspection, and while they came about unsolicited, the department had an opportunity of saying something about the way in which these reconstructions were made, and in nearly every case succeeded in having the original plans so changed as to bring about a smoke betterment. The deputy smoke inspectors, who are all mechanical engineers, secured detailed information of individual plants, and this information was carefully filed among the records, so that during the first few months there was collected a valuable lot of data and information relative to the steam plants of the city. To-day but few cases are brought to the attention of the department, such that no parallel cases can be found by reference to the files. This is a big asset.

On the whole the department has met with splendid co-opera-

tion from the citizens of Chicago in its efforts to carry out this part of the work. The plant owners have shown a surprising willingness to spend considerable sums of money in reconstructing their plants, and in co-operating with the department. The progress seemed slow during the first few months, but as soon as the plant owners became convinced that in stopping smoke they usually saved coal, and that an engineer or fireman who is careful about smoke is also more careful in other ways, they realized that the procedure was right and proper.

Section 14 of the smoke ordinance makes it necessary for the Smoke Inspector to approve the plans of a building, in which a boiler plant is to be located, before work on the building begins. This affords the department an opportunity to start supervision of the plant before building conditions are established that would interfere with design adequate for the prevention of smoke. Any attempt to supervise boiler and furnace installation that would not include the approval of building plans would be next to useless, for space is the most essential requisite for a good plant. Formerly it was the custom for an architect to design a building with the idea of utilizing as much space as possible for renting purposes, and to allow only the least possible space for the boiler room. After the plans were decided upon and the building started, an engineer would be given the job of designing the plant. Consequently there was never enough space available in the boiler room, and the equipment had to be selected in accordance with the space provided rather than in accordance with the needs of the building. This was not always the case, but instances in which architects realized the importance of spacious boiler rooms were very few. Usually the chimney locations and dimensions were determined by the architect, a thing entirely within the province of the engineer, and there was seldom space enough for well-designed furnaces. The breechings had many tortuous bends, the firing space was limited and the ventilation poor. In the existing plants in Chicago, lack of space is the biggest difficulty encountered, when the question of proper furnace and breeching design is considered.

The department does not, as a rule, concern itself with the design of the boiler. This is a fixed thing and presents but little opportunity for special study. The general proportions of the

boiler are considered, however, in order to make sure that the areas of the gas passages through the heating surfaces are large enough to prevent the effectiveness of the chimney draft being destroyed before the furnace is reached. Attention is also given to the means provided for the removal of soot from the heating surface, so as to avoid an accumulation filling the gas passages and interfering with the draft. Quite frequently recommendations are made as to the means of baffling water tube boilers. Where vertical space is limited, preference is shown for the horizontal baffling, so that box or encircling tile can be placed on the lower row of tubes, which provision allows for a long flame travel before the cooling surfaces of the boiler are reached. Vertical baffling, however, is accepted, sometimes urged, if there is sufficient head room to allow for a combustion chamber, in which the flame travel will be equal to that obtained with horizontal baffling and box tile.

The requirements relating to draft are by far the most important. This is the conclusion reached after studying for three years the causes of smoke and noting the shortcomings of plants that have been persistent smokers. Consequently, as this opinion has become more firmly fixed, the department's requirements on height of chimneys have gradually increased. It is not the intention of this paper to give detailed requirements, but it is not out of place to state that the lowest chimney that the department is inclined to accept is one at least one hundred feet above the grate level. This applies only to small plants, such as are usually found in laundries, or in small heating plants where soft coal is used and represents the lower limit of stack height. As the size of the plant increases the required stack height also increases, until for the large central plants a chimney 250 feet high is common. Provisions for meeting the other requirements of smokelessness cannot be carried to the point of taking the place of adequate draft, which is the first and by far the most essential requisite. The sooner that people understand that the chimney is the heart of a plant, the thing that determines the steaming capacity, rather than the amount of heating surface, and that it plays an important part in the economy of fuel, the sooner the general crusade against smoke will be made effective.

The only function of a breeching is to convey the products of

combustion from the boiler to the stack. In designing the breeching, care must be taken to avoid interference with the function of the chimney, which is to get intensity of draft over the fire. Available draft at the base of the chimney is procured by its height, and the money invested in chimneys increases enormously with the height. Therefore, any design of breeching which uselessly uses up the available stack draft is a source of constant loss to the owner, inasmuch as he has money invested in a chimney that is not giving him full return, to say nothing of the annoyance caused by the barrier in the way of smokelessness. Therefore, as much attention must be given to the design of breeching as to the design of chimney.

The department often asks for extensive changes in the general layout of a plant, in order to avoid a right angle turn in the breeching. Sudden changes of cross sectional shapes are prohibited. The general shape of the cross section must be as nearly square or round as possible. If the section of the breeching must be changed in order for it to enter the stack, the breeching must be so arranged that the smoke will go up and not down as it enters. Bends of long radius are substituted for short turns when possible. The design must be such that opposing currents of gases are avoided.

So varied is the number of furnaces in use, and so complex is the question of imposing requirements on all of these many designs, that no attempt will be made in this paper to cover the requirements relative to furnaces and stokers. The department advocates and urges the use of automatic stokers in all plants having a boiler capacity above, say, 300 H. P. The value of an automatic stoker as a smoke preventing device is too well known to require any discussion. The use of stokers has been consistently and earnestly advocated in all of the department's work among stationary plants. Only in the smaller plants, where the conditions are unsuitable for stokers, are hand-fired boilers permitted or approved.

The department has required that all classes of boilers be set higher than has formerly been the practice, in order to provide such combustion space and to allow the installation of proper furnaces. As an illustration, for hand-fired tubular boilers the following have been adopted as the standard distances from the shell of the boiler to the dead plate:

Diameter of Shell. Inches.	Dead Plate to Shell. Inches.
72	42
66	40
60	38
54	36
48	34
42	32
36	30

The standard designs of boiler setting formerly in use all show tubular boilers set nearer to the grates than the dimensions given.

Smoke devices, so called, of which there are perhaps a hundred on the market, and which must be held distinctly separate from furnaces of recognized merit, are not approved by the Smoke Department unless other provision for smoke prevention is made. Such devices usually consist of special means of admitting air and steam to the furnace, in an attempt to supply conditions necessary for complete combustion. One of the principal ideas of those who drew up the smoke ordinance which provided for the supervision of this sort of work by the city, was to provide good engineering advice for the plant owners of Chicago, which would keep them from spending money unwisely in their efforts to prevent smoke. It has been the policy to give people very frank advice about installations of so-called smoke devices, and there is no question but that this has saved the public a great deal of money. The position taken is that these so-called smoke devices in themselves are not sufficient to meet the requirements. However, if a plant owner wishes to build a really good furnace, and in addition to put on the smoke consumer, the department offers no objection.

For the larger sized plants (those in which boilers of 200 or more horsepower each are installed) automatic stokers are required, unless there is some good engineering reason why they should not be installed. Automatic stokers are those which automatically feed the coal and automatically remove the ash. A machine which merely feeds in the coal only does half the work, and is not considered in a true sense an automatic stoker. Much could be written concerning the installation of stokers. A good boiler and a good stoker may be chosen, yet they may be put

together in such a way that the result will be most unsatisfactory from a smoke prevention standpoint. The stoker must be so arranged with reference to the boiler that the combustion of the fuel is complete before the gases come in contact with the boiler itself. There are many stoker fired plants in the city that are not successful in preventing smoke. The fault is not due to the particular boiler or the particular stoker, but to the manner in which the two have been installed in relation to each other.

In general, high settings are advocated, and large combustion spaces. The area of the gas passages through the setting and furnaces must be of sufficient size to allow a good draft over the fire. Similar requirements as to the materials used in the furnace construction of stoker-fired plants are made as in the hand-fired plants. Not only are these requirements looked after when the permit is issued, but the final inspection of the work before the certificate is issued ensures that the job is done in accordance with the plans and specifications filed with the department.

During the last administration a considerable improvement was made in the smoke conditions of Chicago. It is believed that the smoke of the city was reduced fully one-third. The work that was done was far easier than the work that remains, and future workers along this line will not be able to make as good a showing with a department of the same size. Smoke can only be stopped by careful and systematic study of the details of the coal-burning plants and the application of sound engineering judgment. There is no "universal panacea" or "cure all" for the smoke evil. Each case must be given individual attention.

The practical means by which the reduction of smoke in the future will be accomplished may be listed as follows:

1—Electrification of railroads.
2—Central station power and heat.
3—Boats to burn hard coal.
4—Gas and coke for heating.
5—Complete electrification of all power.

The railroad locomotives of Chicago make about 43 per cent. of the total smoke, and the only final solution of the railroad smoke problem is electrification. It cannot be stated too strongly that electrification is absolutely essential, and that it must be brought about if Chicago is to be a clean city. During the present administration the smoke has been reduced one-third. The

easiest part has been stopped, but it is safe to say that the smoke in the atmosphere to-day is only 66 per cent. of what it was in 1907. If the railroads were electrified, the other conditions remaining the same, this figure would be reduced to 38 per cent.

After the railroads the most important factor in the problem is the fact that the total coal used in the city is put into the boiler furnaces by thousands of men, and that the extent to which the smoke is kept down depends upon the individual efficiency and carefulness of a multitude of poorly paid and, in many instances, ignorant workmen. The personal equation of the fireman cannot be eliminated. Therefore the greatest improvement will be made when the number of individuals connected with the use of soft coal is reduced to a minimum and the personal element is reduced as low as possible.

Exclusive of the plants used only for heating, it is probable that there is an army of between 15,000 and 20,000 men constantly employed in the city in burning coal. As long as the smokelessness of the city depends upon the carefulness of this great number of individuals, the work of keeping them at the highest degree of efficiency will be stupendous. The obvious way is in the centralization of plants. In every block in the Central District there are from two to twenty different steam plants. In the manufacturing districts, each factory, no matter how large or how small, has its own power generating outfit. If in place of this multitude of small plants a relatively few number of large power houses could be installed, the result would be most beneficial from a smoke prevention standpoint. For instance, if there were only one stack to each block in the Central District, or, better yet, one stack to each nine blocks, and if this central plant were equipped with the most modern type of boilers and automatic stokers, the smoke could be practically eliminated. As the large plant, equipped in this manner and operating under fairly uniform load conditions, can prevent smoke so much easier than the small hand-fired steam plant, the central station scheme offers one of the most practical means of preventing smoke that is known. This does not require any new inventions or new methods, only the gradual development and increase in the use of central station power and heat.

All boats that navigate the rivers of Chicago must use hard coal, or some other fuel with which smoke cannot be made. This

is necessary if Chicago is to be a city free from smoke. The proposed outer harbor will keep the larger boats outside the city, and when freight vessels enter the rivers they should be moved by tugs burning hard coal.

What has been said about the number of firemen employed in the power plants of Chicago is equally true of the heating plants. Soft coal (Pocahontas) is universally used for heating flat buildings. The smoke from this source is very objectionable because it is produced in the residence neighborhoods. As long as soft coal, or any other fuel from which smoke can be made, is used in these small heating boilers, and handled by ignorant and careless janitors, but little improvement can be expected. The only satisfactory solution of this part of the problem is the use of a smokeless fuel, such as hard coal, gas or coke. Without doubt the methods of making gas and coke from Illinois and Indiana coal will be so improved in the near future that a cheap and smokeless fuel for domestic heating and cooking in private residences, as well as in flat buildings, will be obtained.

There is great opportunity and urgent need for the heating and ventilating engineer to develop low pressure heating plants that can be run on cheap coal and by ignorant firemen without smoke. It is often easier to run a high pressure power plant with a clean chimney than to so run a low pressure heating plant. The task confronting the heating engineer is by no means easy, and it is worthy of the most careful thought and study.

DISCUSSION OF MR. BIRD'S PAPER AND PRESIDENT BOLTON'S ADDRESS.

President Bolton: These two subjects are closely allied one to the other. In New York we are not such sufferers from smoke as are our western cities, that are using almost exclusively so-called "soft" coal. But the time is rapidly approaching when we shall be compelled to make use of the same class of fuel. The price of "hard" coal, on anthracite, has been advanced 25 cents a ton this season for all the smaller and cheaper grades, and it is expected that each succeeding year will see an equal increase in price, which will soon place the material at such a premium that it will be necessary first to use the mixtures, and finally to use soft coal, as the hard coal supply gradually gives out.

It is not too much to say that there is not one boiler in a hun-

dred in New York City that is set in a suitable manner to make proper use even of the mixture of hard and soft coal, let alone the exclusive use of soft coal. Therefore, the condition in New York as regards imperfect combustion will become extremely serious, and is one, moreover, which will have to be considered in the not very distant future.

Such boilers as now use soft coal in New York are generally set too low, which frequently leads to disappointing results. A boiler set too low over the furnace reduces the furnace temperature, and, in the case of water-tube boilers, the inclination of the tubes brings the comparatively cold part against the gases, that are being distilled off at the rear part of the furnace, chills them and prevents their combustion.

An instance in point may be the experience gained in the marine water tube boiler of the Babcock-Wilcox type, with tubes inclined from the front towards the rear part of the furnace, which was first installed on the Plant Line steamer *La Grande Duchesse.* It fell to my lot to find out what was the trouble with that vessel, which was the most smoke emitting nuisance that sailed down the coast, and commonly came into New York with a flame extending 20 feet above the stack. I suggested that the boiler should be raised 1½ feet or turned around end to end, which latter course was eventually followed by the manufacturers, and marine boilers of that type are now installed in hundreds of thousands of horse-power, and are very good smoke-consuming devices.

The effect of bad combustion in the fire is so widespread, that it affects not merely the health of people but it affects property. The injury that is done to fine public buildings by the emission of smoke is very serious and the cost to the community is very large in cleaning such buildings and maintaining air surfaces against deterioration. Some observations made in New York indicate that it is not only soft coal that produces injurious effects upon stone surfaces, but that the gases emitted by hard coal have a similar deleterious effect upon fine cut stone and marble. As an instance, I may mention the new public library, which has only been in course of construction a few years, and which is already considerably discolored, apparently, by the gases emitted by coal.

There is another element which is not inconsiderable, and that is the dust carried from all chimneys and deposited over their

vicinity. I recently asked the commissioner of street cleaning whether he had given thought to the question of how much of the dirt which he annually carted away was due to this cause. He told me he had not done so. I made a computation, based upon a very small percentage of the total matter carried up by chimneys, and found that it ran into tens of thousands of tons of fine ash and dust a year, which seemed to surprise him. I am sure we can all see very readily that cities are fouled by this cause, and that we pay for the removal of the material out of the public funds. So the effect is a cumulative one, in which we are all interested, not only from a standpoint of health, but also from the point of view of our own pockets.

The methods in use in this city, Chicago, in burning the exceedingly difficult fuel, which is handled here, are interesting to any engineer who has to do with the subject of fuels. I made a special journey here to investigate that subject, and I learned a great deal. When you contemplate this Illinois slack, which in some cases contains something like 30 per cent. of moisture and much incombustible matter, I think it is really wonderful that Chicago presents the decent appearance that it does to-day. And, as a body of engineers, we owe a great deal to the Smoke Inspection Bureau of this city in showing us a line of action which may well be followed elsewhere and which has resulted in making Chicago comparatively free from smoke.

I have been particularly interested in the subject of the amount of light provided by nature, and the amount of artificial light consumed in its absence. My observations in a number of buildings have shown that, as the intensity of sunlight declines, so the use of electric light increases. I asked the Weather Bureau here for their records of the intensity of sunlight, and I found that they varied very much from what we find in New York, because in the early morning the sunlight in New York is usually very low. The Bureau informed me that that was due to the pall of smoke which always gathered over the city during the night, and which would hang over the city in the early hours of the morning until the day breeze had blown it away, and showed me how the wind movement was connected with the degree of sunlight intensity. So you see that we often pay for smoke in a third direction, for we actually pay for it in the cost of electric light.

Mr. Busey: I would like to offer a remark about smokeless furnaces. At the University of Illinois we have a 200 H. P. Heine boiler, an exact counterpart of the one tested at the St. Louis exposition. It is equipped with a chain grate stoker, and formerly had a tile roof of C tile; that is, the lower bank of tubes were entirely enclosed with the roof. Furnace temperatures of 2,400, 2,500 and 2,600 deg. were then obtained. At that time we were unable to make the furnace smoke when using Illinois coal. About a year ago the roof was changed from C to T tile, so that the lower half of the tubes were exposed to the flames, and we have been able to make a small amount of smoke, but not at all objectionable. With small house-heating boilers I cannot say as much. I have never been able to devise anything that would prevent them from smoking with Illinois coal, containing 30 or 40 per cent. volatile matter, and with furnace temperature of only 1,200 and 1,400 deg. The volatile matter will not ignite, and the hydro-carbons pass out in the form of smoke, in spite of anything I have ever been able to do.

Professor Hoffman: I wish to say a few words in appreciation of the President's address. I was very much interested, and read it carefully two or three times. The address appealed to me in this way: that it is worth while occasionally for us to theorize upon some of those larger propositions that are just beyond us in order that we may grow in reasoning power. The engineer of to-day, who is a successful engineer, must be endowed with three qualifications: he must be an investigator, he must have the power of logical reasoning, and he must be a man of action. While few have all of these qualifications, all of us have some of them. We all admire the man who tackles a big job. The proposition, as outlined by the President in his address, is something which is worth our consideration and thought. He certainly has shown the spirit of the investigator and of the man of action. Whether there may be some mistakes in reasoning or not, I am not prepared to say. I believe, however, that there is a great deal in the thought, and that our President is to be congratulated upon his ability to present to us a proposition so large that it will take us some time to sit down and think it over.

Mr. Bird: I wish to congratulate the Society on having such a paper as was presented this morning by your President. In a way it is in line with an investigation that was carried on last

year here in Chicago. Although our investigation had a different object in view, the thought came to us, time after time, as to the tremendous amount of heat that was liberated in a city of this size from the use of coal in various ways. We undertook to estimate the coal consumption of Chicago, and found it extremely difficult. We finally decided that about ten million tons of coal were burned each year within the city limits.

Mr. Bolton uses a figure of about seventeen millions in New York. Our figure is a little higher per capita than his; but probably both figures are very nearly correct. In the city limits of Chicago there is probably more manufacturing proportionately than there is in New York. So I think that more coal is used per capita in Chicago than in New York. Our coal also may have less thermal value per ton.

The estimate of the total coal consumption was made for the purpose of deciding where the smoke comes from that is made in Chicago. We divided all of the users of soft coal into seven classes and then we made thousands of observations of the density of smoke produced by the plants of the various classes. With these data, together with the coal consumption of each class, we were able to compute the smoke produced by each class. The results showed that the railroads in Chicago make 43 per cent. of the total smoke. That seems a very generous proportion. They only burn 18½ per cent. of the coal. Of course our railroad situation is quite different from that of New York, for here we have over 30 different railroad companies operating in the city limits. We have about 25 trunk lines, and a number of transfer or belt lines. They are using, as I recall, about 1,500 locomotives, all the time, in the city, and have about 2,200 miles of track.

The next largest producers of smoke in Chicago are the miscellaneous power plants, which class includes all stationary power plants that are making steam for use as power. This class produces 30 per cent. of the smoke.

The next largest producers of smoke are the "special furnaces," or those in steel mills, terra cotta plants, brick yards, reheating furnaces, and all those that burn coal for making heat, that is, not used in the production of steam for power.

The fourth largest smoke producers are the heating plants in the central district. The river craft make 4 per cent. The flats

and the domestic heating plants make only 4½ per cent. of the total smoke. This figure is surprisingly small, but it was the best judgment of those in charge of the investigation. The smoke they make, however, is more objectionable than the smoke from the large factories, because it is emitted at a relatively short distance from the ground and in the residential neighborhoods.

President Bolton: Mr. Bird, what amount of the total coal used is domestic coal in heating plants?

Mr. Bird: About 15 per cent. That figure though does not include the heating of office buildings or of a hotel in the down town district. It is strictly for domestic heating.

Prof. William Kent (by letter): President Bolton's estimate of a rise in temperature of 4.94 deg. over the entire area of the City of New York, 326 sq. miles, to a height of a mile, seems to depend on the assumption that the 326 cubic miles of air remains over the city for 24 hours to be heated. He neglects the facts that heated air always rises, and that there is nearly always a wind blowing over the city. If the heated mass of air rose at the rate of half a mile an hour, or if we assume that the 326 square miles area is a rectangle 32.6 miles north and south, and that a west wind is blowing in a column a mile deep at the rate of 5 miles per hour, then, in either case, there would be twelve changes of air in 24 hours, and the rise in temperature would be only $4.94 \div 12 = 0.41$ deg.

President Bolton (by letter): Professor Kent, as well as most of those who had discussed the subject of the emission of heat, as set forth in the address, failed to note my reference at the foot of page 8 to the assumed absence of wind, and on their part assumed that, as stated by Professor Kent, "there is nearly always a wind blowing over the city."

If those who have criticized the suggestions I advanced would examine the weather conditions of the central part of the City of New York, they would find that the movement of air horizontally is very small at times of the lowest temperature with which my suggestions dealt.

Even if it be conceded that wind is present, the effects of the emitted heat would be felt in that part of the city which lay to the leeward, and over which heated air is being blown.

The past winter season has been one in which exceptionally low temperatures have been reached in and around the City of

New York, but, so far as my observations go, the temperature within the central part of the city was always several degrees higher than that in the suburbs.

I have not observed any substantial criticism of the suggestion that the increase of temperature, due to the heat of the city, can or does affect the rainfall. On the whole, it does not appear that the main points advanced in the address have been weakened by the criticism of those who have written upon the subject in the press, or have taken part in the discussion before the Society.

CCXLIII.

FREE ENGINEERING.

BY GEO. W. KNIGHT AND PERRY WEST.
(Members of the Society.)

Free engineering does not mean what it literally expresses; namely, professional engineering services free of cost. As the subject of this paper, it refers to that portion of engineering work which is being furnished "apparently gratis" by certain manufacturers and contractors. Those who are rendering this service are evidently believers in that famous expression of Mr. P. T. Barnum, "A sucker is born every minute." The expression "professional engineering services apparently gratis" (the bait) is so artfully clothed that the word "apparently" is not discernible.

The cause which has brought about the existing conditions, where the engineer and the contractor are doing a large percentage of the engineering work, is based upon the old proposition of offering something for nothing. This idea is alluring, and has proven quite effective, owing to the fact that the general public do not appreciate that this "nothing" really represents a percentage above the legitimate cost of the apparatus or the work sufficient to maintain an engineering department for furnishing this "something for nothing."

The evil effects of this practice are twofold, affecting chiefly the owner and the engineer. The owner, by either wittingly or unwittingly allowing the manufacturer or the contractor to perform his engineering services, increases the cost or reduces the quality of the work which he receives. The practical reasons for this are simple, but conclusive. In order to render engineering services, the manufacturer and the contractor must add to the cost of their apparatus so as to maintain engineering departments. That the production cost of such engineering is high, as compared with that of the regular engineer, needs no further argument than the fact that it is an intermittent side line of

work, carried on by those whose principal interests and qualifications are centered in their own particular line. That they are fully compensated for this work in proportion to its cost, is a simple, fundamental business proposition. That the services rendered are of an inferior quality, naturally follows from the fact that the plans and specifications must include a number of items, such as pipe systems, duct systems, electric systems and other work, entirely outside of the manufacturer's or contractor's particular line, in the consideration of which they cannot afford to expend the necessary talent and energies. It is folly to suppose for a moment that such plans and specifications are drawn so as to permit of fair competitive bidding, or that apparatus in which the manufacturer or contractor are particularly interested will not be included, regardless of its adaptability to the particular requirements; otherwise, where is the return for the free engineering? We intimate that the owner may act unwittingly in this matter, which means that his architect or agent may use this free engineering without the owner's knowledge, and so the owner not only suffers all of the evil effects mentioned, but pays, in addition, an architect's fee on his engineering work equivalent to or greater than that sufficient to employ a competent engineer. This should be plain enough to good business men, and to engineers who know the cost of producing proper plans and specifications. The owner may say honestly that the quality of work which he receives is satisfactory, but we believe that he is led to say this through his ignorance of what a better quality of equipment would really mean to the success of his undertakings. On the whole, engineering work has risen to a comparatively high plane, especially within the last decade. An equipment of to-day is far superior to what we have been accustomed in the past.

The degree of perfection is measured quite often by the layman by comparison with something inferior, instead of with the best obtainable.

As a representative body of equipment engineers, we are largely responsible for the perfection of attainment in our lines. It is our duty then to inquire as to how well our work is being done, and to develop such ideas as will best advance the quality of this work and the interests of our profession. Necessarily in order that any work may be done well, it must be placed in the hands of unbiased, unrestricted, competent men. The supply of

men who measure up to this standard we believe to be ample for all requirements, but in order to develop, protect and preserve such men it is necessary that they receive the work and the compensation.

Second, the engineer is deprived of a large portion of business, and in a great many instances is forced to reduce his legitimate fee for professional services, in order to secure some of the business that is done "apparently gratis" by others. In addition, the reputation of engineering work in general is discredited by this character of work. The engineer is placed in much the same position as would be occupied by the doctor, if the druggist should maintain a free physician's service by charging enough for his drugs to include the same, or as would be occupied by the manufacturer and contractor themselves, should the engineer manufacture and furnish free apparatus by charging sufficient for the engineering to cover the cost of these items.

The authors of this paper appreciate the fact that its contents will not be particularly pleasing to a great many of the members of this Society. They have not written it in any spirit of malice, but rather with a view of aiding particularly the manufacturer and the contractor in understanding what this practice of "free engineering" means from an engineering standpoint, and how it affects the standing of the profession.

We have discussed this subject freely with many manufacturers and contractors, and are convinced that probably 50 per cent. of them are willing, yes, even anxious to abandon the practice, provided all the others would do the same. They frankly admit the practice to be wrong and harmful to the engineering profession, but they state that it is necessary for them to continue it in order to secure business, for the reason that if they are called upon by an owner or architect to draw heating and ventilating plans and specifications, and refuse to do so, someone else will. The engineers, by a little concerted action, could bring the remaining 50 per cent. into line. Take, for example, the comparison referred to between the physician and the druggist, or the manufacturer and contractor and the engineer. How many physicians do you suppose would recommend that their patients go to such a druggist for their medicines, or how many manufacturers and contractors would recommend such an engineer?

In this connection legislation would accomplish a great deal toward reducing the practice of "free engineering." There does not seem to be any reason why engineers should not be registered, as are physicians and architects. Surely their field is of sufficient importance, and in many instances the life of many persons is dependent upon absolutely correct engineering design.

DISCUSSION.

President Bolton: This is a short, interesting paper, reviving an old subject. I recall that this matter was before our Society a number of years ago, and excited a considerable amount of attention at that time. As an illustration from my own experience let me draw attention to another phase of this question, namely, the cost to the manufacturer of the practice of free engineering advice and design.

Some years ago one of our college buildings in New York City required equipment with a heating and ventilating plant. The architect was a man for whom I had done some work, and I naturally asked the opportunity of designing this plant. He led me to his drafting room, where he showed me nine sets of plans—nine which had been prepared free of cost for him by different contracting firms, each with a different scheme for heating and ventilating that building. I estimated that the actual cost of drafting in each instance was about $160, and if overhead charges were added to the items I should say $300 apiece would probably have been the cost of those plans and specifications to each competing manufacturer or contractor. That makes $2,700, which the trade had paid out, to produce the ventilating plans for one building, and only one of them could possibly get the work.

Assume that his price covered that $300, and that the owner therefore would pay that cost in the price of the work, the other members of the trade lost the rest.

Inquiring further into the practice, you will find it extends into many lines of work; for instance, in steel construction, there has been complaint among my friends in the consulting profession, who state that they also suffer from this unfair competition. One Steel Company is said to employ a force of one hundred and

sixty draftsmen upon free details for steel frames for buildings. One young consulting engineer in the city of New York, who is striving to make a living out of his practice, told me that he had to draw plans for steel framing for buildings for less than one per cent., or he could not get the work. Another man, engaged in that same line of work, is only able to make good by taking the manufacturer's plans and cutting down the amount of steel in the framing to the limit of the law, the difference in cost sufficing to cover his fee. Occasionally you hear of a steel frame building which twists while it is going up, and occasionally hear of one which falls down, as in the case of the Hotel Darlington, an indication of some such practice. I know of one building in the city of New York that has had the steel skinned so close that the engineer in charge told me it was a marvel how it held up long enough to get the curtain walls around it to stiffen it.

Those are illustrations of the widespread character of this practice, which has worked a great hardship upon all parties concerned in design and manufacture. It is productive of no value to them that I can see. Manufacturers, contractors and all professional men should combine with the Association and insist on being paid for plans and specifications. Some of our Philadelphia members at one time got together and insisted that they should be paid two and a half per cent. on the figured cost for all the plans and specifications that they prepared, and they received it in many cases. They are intelligent men, and know how to draw plans and specifications, and such competition with the professional engineers is fair.

This Society certainly does good for those who are engaged both in construction and in professional work by such discussions as this. I would not be in favor of legislation on the subject and have not much faith in the suggestion of licensing engineers. But by constantly bringing this subject forward we shall gain something in the end.

Mr. Bronaugh: It appears to me that what we want is best secured by a campaign of education, because the manufacturers that are doing this free engineering will be the first ones to grasp the opportunity to get away from it. A few years ago I was connected with a concern that did a great deal of this free engineering, as you call it, and we considered it was a pretty heavy

overhead charge to carry. If we obtained all the jobs on which we did engineering, it would be all right, but unfortunately, we did not get more than one out of every five or six. This free engineering meant increased administration cost and increased office cost. In this connection, it might be interesting to know that when the new building code came up this year, there was some talk of providing that every architect should be required to show on his plans the name of an engineer, and that the competency of that engineer would have to bear investigation and he should be free from all entanglements and associations with manufacturing concerns. The time is not ripe for carrying out such requirements, but it shows that all interested parties are thinking.

Mr. Davis: Speaking from the manufacturers' side, my observation is that it would be very difficult for the manufacturer to introduce any new system or anything of a similar character without making plans. The engineer or the architect or the steamfitter will say, "How do we know that this is any good? You have got to guarantee it. Nobody knows anything about it. The only way is for you to give us plans and specifications and we will take our figures from them."

I think that our President knows from his own experience how hard it was to have the best engineers recognize the principles of vacuum heating until the responsibility of their operation was taken by the manufacturers themselves. Recently my observation of the blower system is very much the same. I was amazed when I traveled all over this country to find how little good, real, honest knowledge there was of the blower business. The entire country is brought to rely more or less on the blower companies and to take from them their guarantees and to have them make the layouts. Otherwise, the blower business would never have grown. And we must remember also that the blower companies and large manufacturers are taking young students that graduate from colleges and finding them places and giving them a good business education and good pay.

I know that the manufacturers would be glad to get rid of the engineering expense. As soon as the architect will ask enough commission or fee to hire good engineers, they will do it; but you must begin first with the architect so that he will ask enough to hire competent engineering service.

Professor Hoffman: I think we will all agree that the paper has the right trend, but in reading it over very carefully it seems to me to be somewhat revolutionary. I think this Society can afford to make haste slowly. When it comes to legislation this must be, as has been said, a campaign of education.

CCXLIV.

A PROPOSED BASIS FOR RATING HOUSE-HEATING BOILERS AND FURNACES.

BY FRANK L. BUSEY.
(Member of the Society.)

For small and medium-sized heating installations, steam and hot water boilers and warm-air furnaces are used for the same class of work, depending on the requirements and available funds. Each has its own advantages and its own advocates, so there should be some common or comparable basis of rating, or of making a comparison of the results to be expected from the various units. This rating should be expressed in some small quantity, in order that it be easily handled and comprehended. It should be, if possible, in some well-known and established term, such as The American Society of Mechanical Engineers' standard horse power, universally used in referring to large power and heating boilers. Heating installations will usually range between 2 and 50 h.p., where the installation is intended strictly for heating purposes.

The question of a fair and proper rating for house-heating apparatus has often been discussed, without definite results, and the need of a solution of the problem is sorely felt by all who come in contact with the boiler and furnace business. Some manufacturers are equipped to test their boilers properly, and so arrive at a fairly accurate determination of what performance their product is capable. On the other hand, a considerable number of builders have no adequate means of conducting tests and would be unable to interpret the results in case such tests were made. These are the parties who are guilty of placing apparatus on the market which has a catalogue rating of two to three times what can be developed under normal working conditions. As a result, the business is in an unsatisfactory state as regards ratings, and the crying need of the trade is for some uniform system whereby the heating capacities of the various

types of boilers and furnaces may be closely approximated from the design and dimensions of the unit under consideration.

An appreciation of this need has led the writer to turn his attention to the rating question, with the result that a number of interesting conclusions have been derived. These results will be presented herewith, together with the methods by which they were obtained. A study was made of several hundred tests made by the University of Illinois Engineering Experiment Station on various types and sizes of small boilers and furnaces, and also of tests made on other and larger units, the results of which could be relied upon.

The practice of using 10 or 12 sq. ft. of heating surface in a boiler as equivalent to one horse power is hardly warranted in house-heating boiler work, since the rate of combustion, ratio of heating surface to grate area and consequent variation in efficiency may invalidate such a system. As a matter of fact, the amount of surface required may vary anywhere from 5 to 50 sq. ft. per horse power, depending on the conditions mentioned.

Various forms and combinations were tried and discarded, and it was finally decided to use the term horse power as the unit of heating effect, as applicable to both steam boilers and warm-air heaters. Taking the A. S. M. E. standard of 34.5 lb. of water evaporated per hour from and at 212 deg. F. as equivalent to one boiler horse power, we have $34.5 \times 970.4 = 33{,}479$ B. t. u. as also equal to one horse power. In the case of the boilers, the equivalent evaporation from and at 212 deg. F. per hour divided by 34.5 gives the horse power developed. With the warm air furnaces the pounds of air heated per hour multiplied by the rise in temperature and the specific heat of air, gives the number of B. t. u. delivered per hour to the air. This in turn divided by 33,479 gives the horse power developed by the furnaces.

Having determined the total horse power developed by the various units tested, the next step was to find some dimension, relation, or ratio to which the horse power developed could be referred, and so obtain a unit to which the horse power would bear some definite relation. It was found that the horse power developed upon each square foot of grate by one pound of dry fuel burned per hour on each square foot of grate surface was remarkably constant. This is true for any one boiler or furnace

when burning dry coal per square foot of grate per hour between the limits of 4 to 8 lb. for small units and 5 to 10 lb. for the larger units, and when using coals of a similar quality. This is shown very clearly in Figs. 1 and 2 for two separate units, each using two classes of fuel. This value, termed a horse power constant, and designated by the letter *K*, was obtained for each test analyzed, by dividing the horse power developed by the grate area, and this quantity in turn by the rate of combustion. Since frequent reference will be made to the grate area and the rate of combustion for any one heating unit, these terms will be designated by the letters *G* and *F*, respectively.

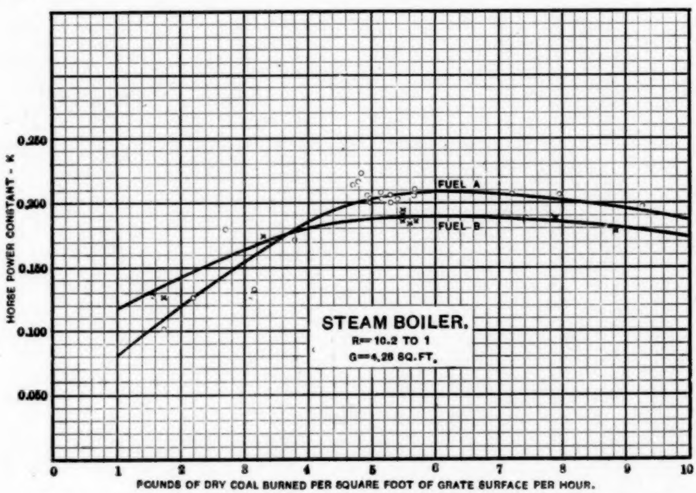


Fig. 1.—Relation of Horse Power Constant to Rate of Combustion.

While *K* was constant for any one unit and for a similar quality of coal, yet different units gave different values of *K*. It was found that the higher values of *K* were obtained from units having a greater number of square feet of heating surface for each square foot of grate, this number being the ratio of the total square feet of heating surface to the square feet of grate. This ratio will be designated by the letter *R*. For a similar quality of coal, the values of *K* from the different units were then plotted to the corresponding values of *R*, as shown in Fig. 3. It is seen that there exists a very definite relation between the values of *K* and *R*.

This relation appears reasonable, for, other conditions being equal, higher efficiencies will be obtained with higher values of *R*. Thus in practice it is customary to use additional sections, resulting in higher values of *R*, and also greater capacity. The relation between *K* and *R* was found to be independent of the size of the unit tested, inasmuch as increase in size is usually accompanied by an increasing value of *R*. This accounts for the higher efficiencies obtained from large units.

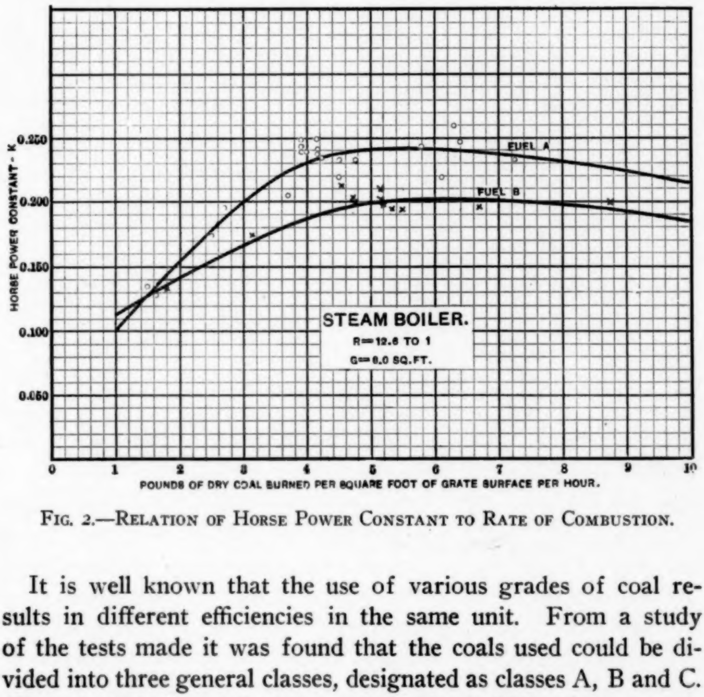


FIG. 2.—RELATION OF HORSE POWER CONSTANT TO RATE OF COMBUSTION.

It is well known that the use of various grades of coal results in different efficiencies in the same unit. From a study of the tests made it was found that the coals used could be divided into three general classes, designated as classes A, B and C. Class A includes anthracite, coke and semi-bituminous coals. Class B includes good grades of bituminous coal, such as is mined in Williamson, Franklin and Saline counties of the southern District of Illinois. Class C includes the poorer grades of bituminous coals. We have already seen that when using any one class of coal a definite relation exists between *K* and *R*. Although different values of *K* are obtained when using the different classes of coal, yet each class has its own definite relation

between K and R. This is well illustrated in Fig. 3, where the three curves refer to the different classes of fuel.

Table 1 shows the average proximate analyses of the three classes of coals as they were used during these tests. The term "good" or "poor," as here used, refers to the performance of

TABLE 1.—AVERAGE PROXIMATE ANALYSIS OF FUELS USED, FUEL AS FIRED

	Fixed Carbon Per cent.	Volatile Per cent.	Moisture Per cent.	Ash Per cent.	Sulphur Per cent.	B.t.u. Per lb.
Class A—Anthracite	78.25	7.13	3.49	11.15	1.30	12820
Coke	80.50	3.26	6.30	9.94	0.90	12015
Semi-bituminous	74.57	18.79	1.49	5.15	0.74	14780
Class B—Bituminous	49.07	34.91	6.84	9.19	1.82	12250
Class C—Bituminous	41.59	38.05	10.79	9.57	2.97	11340

the coal when used in small house heating units and not for large power boilers. The comparatively low furnace temperatures attained in the smaller furnaces make it impossible to burn completely the excessive amounts of volatile matter contained in these coals designated as "poor bituminous." For this reason they soot up the flues and cut down the efficiency.

It is customary in order to get the same heating effect, to build warm-air furnaces with a much greater value of R than is used with steam and hot water boilers. This is on account of the fact that more heat can be transmitted through one square foot of heating surface to water than to air. Tests show that in warm-air furnaces R must be from two to three times as large as in boilers to give the same efficiency, and corresponds very closely with practice.

As a result of these facts, K does not bear the same relation to R in furnaces as in boilers, due to the greater value of R necessary in furnaces to obtain the same value of K. It follows that the relation of K to R varies, not only with the different class of fuels used, but with the different type of heating unit, being clearly shown in Fig. 3.

Fig. 3 shows the relation between the horse power constant K and the ratio of total heating surface to grate area R. The general relation of the curves A, B and C for furnaces and curves B and C for boilers is seen to be very similar, the better fuels

giving the higher efficiencies. This difference increases slightly as the value of R increases. An increase in the value of R is accompanied by an increase in the value of K only in so far as the value of R is confined to the limits found in practice. These limiting values of R for boilers in which this relation was found to hold are between 8 and 15. This range for furnaces, however, is from 15 to 38. It is quite probable that the higher value of 15 set for R in the case of boilers can be increased to 20 or

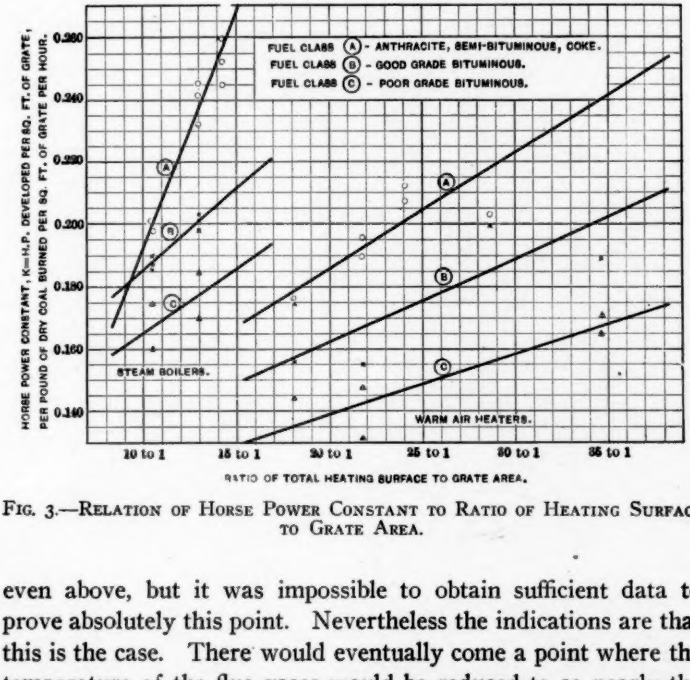


FIG. 3.—RELATION OF HORSE POWER CONSTANT TO RATIO OF HEATING SURFACE TO GRATE AREA.

even above, but it was impossible to obtain sufficient data to prove absolutely this point. Nevertheless the indications are that this is the case. There would eventually come a point where the temperature of the flue gases would be reduced to so nearly the temperature of the surrounding water or air that no further gain would be effected by increasing the radiating surface.

Curve A, in the case of the boilers, shows a much greater difference in favor of the high carbon over the bituminous coals as the radiating surface is increased. This difference is probably due to the comparatively restricted flue passages as ordinarily used in steam and hot water boilers, in which the soot from the bituminous coals tends to deposit and so cut down the efficiency.

In warm-air heaters the radiator is usually made of such ample proportions that less difficulty is experienced with soot deposits. If the ratio of heating surface to grate could be increased, and at the same time the gas passages kept of ample size, curves B and C would no doubt tend to assume an inclination more nearly like that of curve A.

It is evident that an increase in the radiating surface of boilers is productive of greater gain in efficiency when using Class A fuels rather than the ordinary bituminous coals. With boilers having a low value of R a good grade of bituminous coal may be expected to give as good results as are to be obtained with anthracite or eastern semi-bituminous coals.

Having found that the values plotted in Fig. 3 can be represented by straight lines within the limits of the tests used, the next step was to derive a formula and determine the proper constants applicable to the various sets of conditions.

Let G = Area of grate surface in sq. ft.
F = Pounds of dry fuel burned per sq. ft. of grate surface per hour.
R = Ratio of total heating surface to grate area.
K = Horse power constant = h. p. developed per sq. ft. of grate, per lb. of dry fuel burned per sq. ft. of grate per hour.
h.p. = Total horse power developed.
C_1 and C_2 = constants for any one set of conditions.

It will be noticed that the average deviation of the points from the lines as drawn is less than 3 per cent., and that the maximum deviation is 7.5 per cent. This shows how closely actual performance, as shown by a study of several hundred tests, may be approximated by the use of the formulæ and constants given in Table 2.

TABLE 2.—VALUES OF C_1 AND C_2 FOR THE FORMULA $K = C_1R + C_2$

	Fuel	C_1	C_2
Steam Boilers	Class A—Anthracite, Semi-bituminous, Coke	0.0150	0.046
	" B—Good Grade Bituminous	0.0052	0.135
	" C—Poor Grade Bituminous	0.0041	0.126
Warm Air Heaters	Class A—Anthracite, Semi-bituminous, Coke	0.0037	0.112
	" B—Good Grade Bituminous	0.002	0.110
	" C—Poor Grade Bituminous	0.0020	0.101

Then these lines are represented by a formula of a form

$$K = C_1R + C_2 \quad \text{(a)}$$

In this formula C_1 and C_2 have definite values for any one set of

conditions—that is, for one type of heating unit in various sizes, when using one class of coal.

The various sets of values for C_1 and C_2 have been carefully determined and are tabulated in Table 2. Thus the formula for warm-air heaters for a fuel in class A becomes

$$K = 0.0037R + 0.112$$

For any unit under consideration this formula gives us the value of K, or the horse power that is developed on each square foot of grate surface by each pound of fuel burned per square foot of grate per hour. Knowing K, the grate area, and the most desirable rate of combustion, the total horse power developed can be readily determined by the formula

$$\text{h.p.} = K \times G \times F \dots\dots\dots\dots\dots\dots (b)$$

The A. S. M. E. standard of 34.5 lb. of water evaporated as one horse power was used, hence 1 h.p. = 33,479 B.t.u. This in turn divided by 250 gives the number of square feet of direct radiating surface carried—taking the standard of 250 B.t.u. emitted per square foot per hour. With warm-air furnaces the B.t.u. delivered to the air per hour divided by 1.4356 (the heat required to raise 1 cu. ft. of air from zero to 70 deg. F.) gives the equivalent cubic feet of air heated from 0 deg. to 70 deg. F.

As previously explained, the value of K, of the B.t.u., or of the heating effect, as given in Tables 3 and 4, when multiplied by G and F give the total horse power developed, total B.t.u. deliv-

TABLE 3.—VALUES OF HORSE-POWER CONSTANT K FOR VARIOUS VALUES OF RATIO R, STEAM BOILERS

R Ratio of Total Heating Surface to Grate Area	Fuel A			Fuel B			Fuel C		
	K Horse Power Constant	B.t.u. per Hour Delivered to the Water	Square Feet of Radiation Served	K Horse Power Constant	B.t.u. per Hour Delivered to the Water	Square Feet of Radiation Served	K Horse Power Constant	B.t.u. per Hour Delivered to the Water	Square Feet of Radiation Served
8 to 1	0.166	5560	22.2	0.177	5925	23.7	0.159	5320	21.3
9 "	0.181	6060	24.2	0.182	6090	24.4	0.163	5455	21.8
10 "	0.196	6560	26.2	0.187	6260	25.0	0.167	5590	22.4
11 "	0.211	7065	28.3	0.192	6430	25.7	0.171	5730	22.9
12 "	0.226	7565	30.3	0.197	6595	26.4	0.175	5865	23.5
13 "	0.241	8065	32.3	0.203	6785	27.1	0.179	6000	24.0
14 "	0.256	8570	34.3	0.208	6960	27.8	0.183	6135	24.5
15 "	0.271	9070	36.3	0.213	7130	28.5	0.188	6280	25.1
16 "	0.286	9575	38.3	0.218	7300	29.2	0.192	6420	25.7
17 "	0.301	10075	40.3	0.223	7465	29.9	0.196	6550	26.2
18 "	0.316	10575	42.3	0.229	7665	30.7	0.200	6690	26.8
19 "	0.331	11080	44.3	0.234	7835	31.3	0.204	6830	27.3
20 "	0.346	11580	46.3	0.239	8000	32.0	0.208	6965	27.9

ered, or total heating effect, under the conditions assumed. Fig. 4 for boilers and Fig. 5 for furnaces have been drawn to show more clearly the effect of the various combinations of the factors

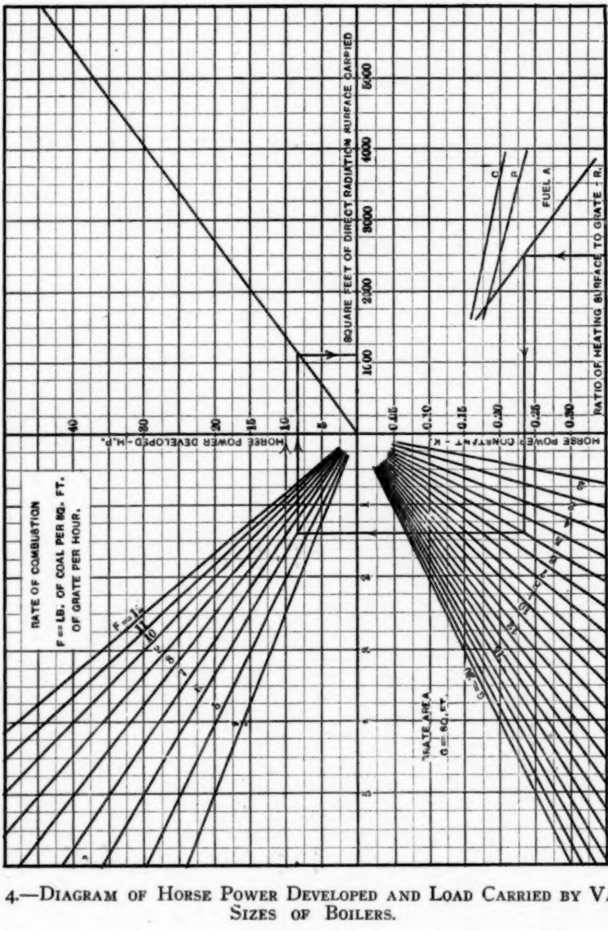


FIG. 4.—DIAGRAM OF HORSE POWER DEVELOPED AND LOAD CARRIED BY VARIOUS SIZES OF BOILERS.

already discussed. From these figures can be readily traced the entire course from heat unit to the horse power developed for any set of conditions.

Referring to Fig. 4 let us assume a boiler with a value of $R = 12.5$, a grate area of 6 sq. ft. and a rate of combustion of

$F = 6$ lb. Then, if we are to use anthracite, we will follow the vertical line upward from the point where $R = 12.5$ until we intersect the line A. From this intersection we follow the horizontal line to the left through the point $K = 0.235$ until we intersect the line $G = 6$. From this point we trace the vertical line upward until we reach the line $F = 6$. Following the horizontal line to the right from this point it is seen that under these conditions the horse power developed is 8.5. On tracing it farther to the right until we intersect the diagonal line, then dropping down-

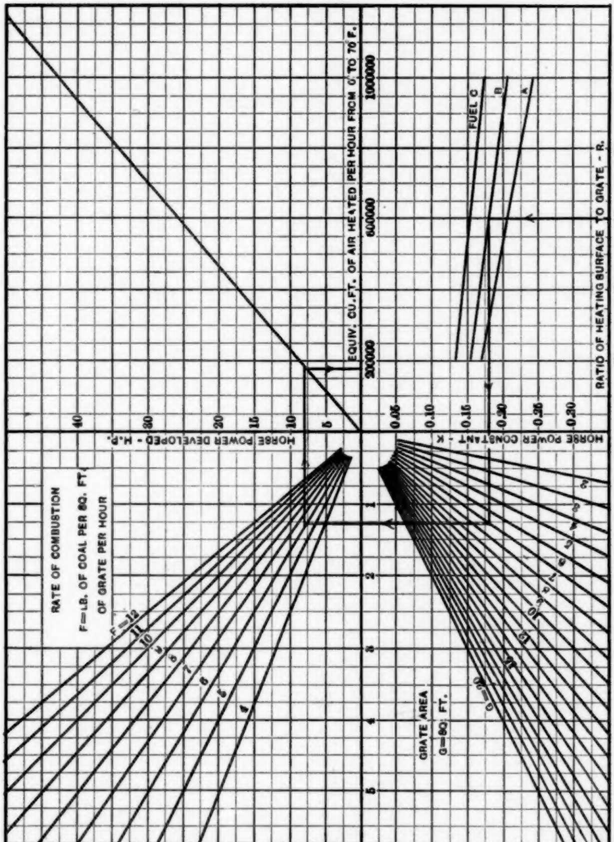


FIG. 5.—DIAGRAM OF HORSE POWER DEVELOPED AND LOAD CARRIED BY VARIOUS SIZES OF FURNACES.

ward on the vertical line we find the equivalent heating surface served to be 1,150 sq. ft.

In the same manner for warm-air furnaces on Fig. 5, the values can be traced as shown. From $R=25$, fuel B, $G=7$, $F=6$, to 7.8 h.p. or a heating effect of 180,000 cu. ft. of air warmed per hour from 0 deg. to 70 deg. F. This operation can be reversed, with either Fig. 4 or 5, thus working from the amount of heat needed back to the unit to be selected.

TABLE 4.—VALUES OF HORSE-POWER CONSTANT *K* FOR VARIOUS VALUES OF RATIO *R*, WARM AIR HEATERS

	Fuel A			Fuel B			Fuel C		
R Ratio of Total Heating Surface to Grate Area	*K* Horse Power Constant	B.t.u. per Hour Delivered to the Air	Equivalent Cu. Ft. of Air Heated per Hour from 0° to 70°F.	*K* Horse Power Constant	B.t.u. per Hour Delivered to the Air	Equivalent Cu. Ft. of Air Heated per Hour from 0° to 70°F.	*K* Horse Power Constant	B.t.u. per Hour Delivered to the Air	Equivalent Cu. Ft. of Air Heated per Hr. from 0° to 70°F.
15 to 1	0.168	5610	3906	0.151	5040	3511	0.131	4385	3054
16 "	0.171	5730	3993	0.153	5130	3573	0.133	4455	3103
17 "	0.175	5855	4078	0.156	5220	3636	0.135	4520	3148
18 "	0.179	5980	4165	0.159	5310	3699	0.137	4585	3194
19 "	0.182	6105	4251	0.161	5400	3761	0.139	4655	3243
20 "	0.186	6225	4338	0.164	5490	3824	0.141	4720	3288
21 "	0.190	6350	4424	0.167	5580	3887	0.143	4785	3333
22 "	0.193	6475	4510	0.169	5670	3950	0.145	4855	3382
23 "	0.197	6600	4597	0.172	5760	4012	0.147	4920	3427
24 "	0.201	6725	4683	0.175	5850	4075	0.149	4990	3476
25 "	0.205	6845	4769	0.178	5940	4138	0.151	5055	3521
26 "	0.208	6970	4855	0.180	6035	4204	0.153	5120	3566
27 "	0.212	7095	4942	0.183	6125	4266	0.155	5190	3615
28 "	0.216	7220	5028	0.186	6215	4329	0.157	5255	3660
29 "	0.219	7340	5114	0.188	6305	4392	0.159	5325	3709
30 "	0.223	7465	5201	0.191	6395	4455	0.161	5390	3754
31 "	0.227	7590	5287	0.194	6485	4517	0.163	5455	3800
32 "	0.230	7715	5373	0.196	6575	4580	0.165	5525	3849
33 "	0.234	7835	5459	0.199	6665	4643	0.167	5590	3894
34 "	0.238	7960	5545	0.202	6755	4705	0.169	5660	3943
35 "	0.242	8085	5632	0.205	6845	4768	0.171	5725	3988
36 "	0.246	8210	5718	0.208	6935	4831	0.173	5795	4034

CONCLUSIONS.

(*a*) Any basis of rating selected for heating installations should be equally applicable to steam and hot water boilers and to warm-air furnaces, as they are used for similar requirements.

(*b*) A unit of rating should be of such a character that it may be easily expressed and comprehended, of some standard form that may be compared to that used for power boiler rating.

(*c*) The term horse power as used in the A. S. M. E. rating for power boilers is a measure of heat delivered, is applicable to both boilers and furnaces, and fulfills better than any other term the above requirements.

(*d*) The heat generated, or the power developed, on each square foot of grate by the combustion of one pound of fuel on that square foot of grate, has been found to be practically a constant, under the conditions as already outlined. This is true of both boilers and furnaces.

(*e*) This constant bears a definite relation to the size of the heating unit, as expressed by the ratio of its total heating surface to grate area. Based on the results of actual tests, this relation can be expressed by a simple formula and the above constant determined for different units and sets of conditions.

(*f*) The difference between the horse power developed by actual test and that calculated by the use of this formula is comparatively slight. The calculated horse power may be used in connection with the ordinary heating job, with entire satisfaction.

(*g*) The use of the diagrams Fig. 4 and 5 will expedite the work of calculation, and for any ordinary case is sufficiently accurate. Where greater accuracy is desired the formulæ (*a*) and (*b*) and the values of C_1 and C_2 from Table 1 may be used.

DISCUSSION.

Mr. Busey: If you wish to ask any questions I will endeavor to answer them.

Mr. Weinshank: In the case of line C, 15 to 1, what would you get for 2,000 sq. ft. of radiation?

Mr. Busey: That is the poorest grade of Illinois coal. What size grate area would you assume?

Mr. Weinshank: About six square feet.

Mr. Busey: From the ratio 15 to 1 draw a line upward on the chart, Fig. 4, to line C, and then across to the line of six sq. ft. of grate area. From this point draw a vertical line crossing the combustion lines. From the 2,000 sq. ft. radiation point, draw a vertical line till it intersects the diagonal, then to the left through 15 h.p. till it intersects the first vertical. The point of intersection will fall above the 12 lb. line, and we would have to burn about 13 lb. of coal per sq. ft. of grate per hour.

I have seen cases where the required consumption would be from 12 to 15 lb. per sq. ft. of grate per hour, in order to carry the capacity claimed for the boiler. A grate area of six sq. ft.

and a rate of combustion of 15 pounds, would require 90 lb. of coal per hour, or 720 lb. for an eight-hour period. No furnace of that size will hold that much coal or stand that rate of combustion, the only solution being very frequent firing or a larger furnace.

Professor Hoffman: I have in mind a boiler carrying about three thousand sq. ft. of radiation, twenty-one sq. ft. of grate, with a good grade of Indiana coal. How much coal should be used?

Mr. Busey: We will assume that it is fuel B, and that the ratio of heating surface to grate is probably 17½ to 1. Passing to the left from the intersection with line B to a point just beyond the 20 sq. ft. of grate line, then upward to the line drawn back from the 3,000 sq. ft. of radiation point, gives a rate of combustion of a little less than 5 lb. per. sq. ft. of grate per hour. This rate of combustion is low, and would indicate that the boiler is larger than required for the load carried.

Professor Allen: I would like to ask Mr. Busey in making these tests are the boilers rated on firing for eight hours?

Mr. Busey: No, we fire about 17 pounds per square foot of grate at a firing and fire as often as required. We found that gave a very good amount of fuel for one firing; that is, with a grate area of 4¼ square feet, a small round boiler gives 75 pounds at a firing, and for a boiler having 6 sq. ft. gives 105 pounds. The boilers were fitted with pressure regulators, so that when the pressure fell below four pounds the damper opened and the pressure came up again. When the final fire was burned too low to pick up again, it was dumped and the test closed. With the warm air furnaces, having smaller grates, as low as 50 pounds was fired as a charge. But this amount was always the same, and the length of time required to burn it depended on the rate at which the boiler or furnace was being operated.

The boiler delivered steam through a separator. I had a union in the line, into which I could insert any size of orifice that I cared to use, just a little disk with a hole in it. I soon got that calibrated, so I could have any load I wanted. So by using different sized orifices I could send as much steam through as I cared to make; and I watched the feed water so I knew how much water was evaporated. In that way I could run the boilers at any per cent. capacity that I desired.

Professor Allen: Did you put the feed water in warm?

Mr. Busey: Yes.

Professor Allen: Return it from the steam coils?

Mr. Busey: I returned it from the heating coils. It is good practice always to use condensed steam from the heating system so as not to scale up the boilers.

Professor Allen: In determining these results, could you distinguish between the fire surface of the boiler and the flue surface of the boiler?

Mr. Busey: No, I took here the total heating surface. That will make some difference, but I have not been able to determine just what per cent.

It is difficult to learn from manufacturers just what they consider as direct and indirect heating surface, and different persons might obtain different measurements from the same boiler. In determining the value of my ratio R, I have considered the total heating surface, and as far as I can judge, it has not made any serious difference in the results.

When you add extra indirect surface and the passages are tortuous, more or less restricted, they soon fill up with soot from the coal and that kills the draft. When burning anthracite coal, this added indirect surface gives the best results. That is shown by the direction of the lines in Fig. 3, page 247, where curve A rises very rapidly. With the addition of more indirect surface and a greater ratio R, the greater the effect for anthracite; while in the case of bituminous coal the benefit is not nearly so great.

Professor Allen: Then to give this chart universal application, you would have to know the proportion of fire surface and flue surface of the boiler, or else have the line developed for that particular boiler. Wouldn't that be true?

Mr. Busey: I hardly think so. I have been able to obtain the results of a good many tests and have plotted them, and it surprised me how closely they agreed, irrespective of how much was direct or how much indirect surface, and irrespective of the shape of the boilers.

Mr. Mackay: Do I understand you that these straight line curves in Fig. 3 are based on the performance of a large number of boilers?

Mr. Busey: On quite a number—all the tests I could obtain and could depend on.

Mr. Mackay: I think that straight-line relation between the ratio of grate surface and heating surface is quite remarkable; and it seems to me that, if it is based on a large number of observations you have made, it practically overcomes the obstacle, to which Professor Allen refers, of the necessity of knowing the relative amounts of flue and direct surface. The basis of rating seems relatively unimportant; that is, we do not need to rate a boiler in terms of horse power, because that, after all, means a definite number of heat units which we can readily translate into so many square feet of direct radiation.

Referring to the Figs. 1 and 2, I made a brief calculation to note the efficiency of the boilers. Fuel A in Fig. 1 shows that we have a little less than 55 per cent. efficiency; fuel A, in Fig. 2, shows a little over 61 per cent.; calling the heating value 13,000 for anthracite.

Mr. Busey: The boiler in Fig. 2 had a greater ratio of heating surface to grate than the one in Fig. 1, which shows that the greater the ratio the higher the efficiency. When burning Illinois coals, this advantage is in a great measure offset by the deposits of soot in the indirect flue passes. In a boiler with a small value for ratio R, and large direct flues connecting to the smoke pipe, the soot will burn out at frequent intervals. When these flues are long and small they soon fill up with soot, with a consequent loss in efficiency. In such boilers the soot deposits seldom burn out, but must be cleaned out with brush or scraper.

I have had cases where the flues were almost closed, and the fire extinguished for lack of draft. In the first class of boilers I have frequently seen the smoke-pipe red hot, with stack temperatures as high as 1,300 degrees.

Secretary Macon: The evidence indicates, in Figs. 1 and 2, a relatively constant efficiency for a considerable range and rate of firing. I do not recall seeing similar tables, but that point has been raised, particularly in catalogue ratings, where it is evident that the rating has been a mathematical calculation. That is, one particular test has been made, a given performance of a boiler, and then a series of ratings has been developed simply as a piece of mathematics. These curves, however, show that if we do not give these ratings for, say, less than four pounds per sq. ft. of grate, the error is not great.

Mr. Busey: I have found, with most boilers, that the efficiency

curve is fairly flat, within 80, 100 or 120 per cent. of the boiler's rating; from about 80 to 100 per cent. of the boiler's rating, the efficiency is fairly constant. The high point will be perhaps at 90 per cent. or so; and above 120 I have forced these house-heating boilers 60 per cent. overload, and the efficiency began to drop off rapidly. Then again, I have run them as low as 16 to 18 per cent. of their capacity, and the efficiency dropped to perhaps 20 per cent.

Secretary Macon: Would you regard it as proper to give a boiler rating on a 160 per cent. performance, that is, a 60 per cent. overload?

Mr. Busey: Well, at the 160 per cent. the efficiency will drop off quite a little. With the ordinary boiler, in order to get 50 per cent. overload, the ash-pit damper will have to be open practically all the time to have all the draft possible, and coal must be shoveled at frequent intervals. That is, you could not fire the boiler in the morning and expect to have any fire there at night if you had it opened up and running at a 150 per cent. rate. The fire-pot would not have sufficient capacity to hold fire for many hours.

Secretary Macon: Would you fix the rating of a boiler at the peak of the actual curve?

Mr. Busey: I would be inclined to place the rating at slightly above the most efficient point. A boiler will be required to develop its full load only at infrequent intervals, and during very severe weather it can develop considerable overload without serious loss of efficiency.

President Bolton: The Chair would like to say a word or two about the value and appropriateness of this paper. You have here a picture of the combinations that cover the question of boiler efficiencies; first, the rate of combustion varied by the draft and by the attendant labor; second, the character of the fuel, a feature over which no control can be exercised by the attendant; and finally you have the appliance itself, that is, its proportions related to its grate area. In those three elements is the whole combination of effective fuel combustion in all boilers. The tests described in this paper are in line with the work which this society has been endeavoring to do for some years past in connection with standardizing the rating of boilers; and it seems to me it would be proper to refer this paper to our Committee

on Standards as an addition to their sources of information, and a helpful means toward the end that they are trying to reach. Our Committee on Boiler Ratings reported at our last annual meeting, and was discharged, having apparently proceeded as far as they could. But this paper appears to reopen the door to further study.

The observations in Mr. Busey's paper present one point of great value, the testing of steam boilers at low ratings, and correspondingly low rates of combustion. It is surprising how little has been done in that direction with large steam boilers. In the past four years I have searched, corresponded and inquired high and low among the large boilermakers for tests run below 50 per cent. of boiler ratings, and I do not find any one who has such records.

Inasmuch as a great many power boilers and house-heating boilers are run for a considerable portion of their time very much below their ratings, sometimes much below 50 per cent. of their ratings, it becomes important to know what they will do at such low load factors. Mr. Busey has tested boilers down to as low as 15 per cent. of their capacity, and has found their efficiency decline to about 20 per cent., which is an excellent index of the cause of inefficiency of steam-heating boilers, because during a large part of the heating season in any place low output is required.

Professor Hoffman: I think Mr. Busey has given us a splendid paper. I have a couple of questions I would like to ask. He states that "Tests show that in warm air furnaces R must be from two to three times as large as in boilers to give the same efficiency, and corresponds very closely with practice." I wonder if Mr. Busey does not consider this a very strong statement.

Then I would like to inquire also in regard to the draft. Was the draft the same in all the tests? Were all the tests run with the same size and height of chimney?

Mr. Busey: The setting, stack, draft and all was the same for all the tests. The stack was about seventy in. in diameter, if I remember rightly, and some thirty-five ft. tall; and the draft was the same comparatively in all the tests, varying only with weather conditions.

As to the Professor's point about the ratio of heating surface

to grate, I haven't any definite information here with me. I have it at home in my files, and the figures were based on actual measurements, most of them taken by our office at the university, I do not think I made any blunders.

Mr. Sterrett: What do you consider the right amount of coal per sq. ft. that should be burned per hour in a furnace, and also did you take into consideration the size of the combustion chamber relatively to the grate, and would the retention of the gases in that combustion chamber, by the tortuous passage in the boiler, have anything to do with the rating of capacity?

Mr. Busey: As to the first question, I mentioned the limit for the burning of coal per sq. ft. of grate per hour as 4 to 8 lb. for small units and 5 to 10 lb. for larger ones. Now a boiler, with a grate, say, 15 to 20 sq. ft. might well burn 10 lb. with a good efficiency. Ten lb. would be about the upper limit. For small boilers, with 5 or 6 sq. ft. of grate, I have set the limit from 4 to 8 lb.; with good draft 8 lb., 4 lb. for running light. About 5 or 6 lb. is a good average and perhaps 8 lb. for a large furnace. In a school-house installation, a furnace with 15 or 20 sq. ft. of grate might burn 8 or 9 lb. of coal right along in the winter, with a correspondingly greater amount in severe weather. As to the second question, if the passages are long and extract more heat from the gases, the efficiency and capacity will be increased, provided these passages are not so restricted that they will become filled with soot. Ordinary warm air furnaces, as usually built, do not seem to have as much trouble with the soot deposit as the larger boiler, their passages being comparatively larger. I recall some cases, where this was not the case, where I would have to clean out once a day. The ordinary furnaces as installed through the middle west are of cast iron and steel construction, the passages being large and open so that perhaps one cleaning a season will answer.

Mr. Newport: I would like to ask Mr. Busey what was the most economical grade of fuel.

Mr. Busey: I have not made any very definite study as to comparative economy. The grade or kind of fuel is sometimes determined by the style of boiler or by other considerations, such as cleanliness and smokelessness. When these features are not of absolute importance our western bituminous coals are the most economical to use. A mixture of lump and slack gives good re-

sults, using more slack in mild weather and less during the cold season.

Mr. Davis: Was there any attempt made to have a uniform draft for these different boilers and different rates of combustion?

Mr. Busey: No, the draft was natural draft, just due to the chimney, varying somewhat with weather conditions. Some days the draft would not be as good, perhaps, the weather was moist and heavy, but the draft was about the same all the time.

CCXLV.

TESTS OF WARM AIR FURNACE PIPING.

BY A. W. GLESSNER.
(Member of the Society.)

"Conservation" and "Efficiency" are two of the watchwords of the hour, and to no class of men should they appeal more keenly than to the members of the American Society of Heating and Ventilating Engineers, as they are engaged in the study of the best and most economical methods of providing sanitary heat for the millions of American homes and other buildings, used and occupied by human beings, whose lives and pocketbooks are directly or indirectly affected. That there is ample field for the profession is indicated by the recent statement of the U. S. Geological Survey that the fuel waste in this country amounts to more than half a billion dollars annually. There is therefore great need of the conservation of our fuel supply, and equally great need of more efficient methods of burning fuel, in order to lessen this stupendous waste. We are told that the modern steam engine, using the product of the best type of boiler automatically stoked, rates so low in efficiency, that only a mere fraction of the heat units contained in the fuel consumed are utilized. A test of smoke temperatures, and an examination of the character of the emissions from smokestacks, demonstrates beyond question the wastefulness of modern methods of combustion and offers prolific opportunity to the inventive genius of the country to get busy on the problem of fuel and heat conservation.

Three score and more of the leading makers of warm air furnaces have joined together for the purpose of testing scientifically the efficiency of their heaters, and within a very few months they will know with reasonable accuracy the comparative efficiency of the numerous types of furnaces in the market, and will thus be able to determine the kind of apparatus best adapted to the needs of certain sections of the country and to different

classes of buildings. It will be possible to guarantee, with definite certainty, the heating of structures and to estimate the fuel consumption within a limited range. The effect of these tests should be to raise the standard of furnace construction, as it is probable that types which are known to be uneconomical will be abandoned or improved. A campaign of education, through the furnace dealer, will soon enlighten the furnace user as to the relative economy and efficiency of various types, and bring about a survival of the fittest.

One need, that all tests of furnaces has demonstrated, is that of providing suitable insulation for furnace casings and bonnets in order to prevent loss of heat between the heater and the point of delivery at the boot or box collar. This has been shown in some tests to be as high as 11 per cent. By lining the casing and covering the leader pipes with cellular asbestos paper, much of this heat loss can be overcome. The ordinary asbestos paper, as shown in the recent Underwriters' Laboratories' tests, is demonstrated to be almost valueless as an insulator as at present applied. It is necessary to have an air space in connection with the paper in order to obtain satisfactory results. In the recent Underwriters' Laboratories' tests, an Excelsior "F" pattern furnace, with cast pot and dome and wrought steel radiator, was used with unlined casing, and during the test it developed that within two feet from the furnace casing 7 deg. of heat were lost and within seven feet 27 deg. As the velocity under this particular test was 472 feet per min., or fully 50 per cent. above normal as compared with velocities registered by the Federal Furnace League in their test of the same pattern of furnace, the result is fairly satisfactory, but with proper insulation the heat loss should be very greatly reduced.

Another form of heat loss, even more important than that noted, has been located in the recent tests of Excelsior double wall pipe, in connection with single pipe and single pipe wrapped with two thicknesses of asbestos paper. The results have been reproduced in last week's issues of the leading trade journals and are doubtless known to you. The tests were conducted over a period of many months by the Underwriters' Laboratories of Chicago, an enterprise owned and conducted by the insurance companies for the purpose of ascertaining the efficiency and fire hazard of building materials and equipment. By reference to

Fig. 1, you will observe that at point "E," which is near the register outlet (see Fig. 3), Excelsior double wall pipe delivered 88 per cent. of the heat values transmitted to it at the boot collar, indicated on diagram as "A," whereas asbestos-covered pipe delivered only 78 per cent. Attention has already been called to

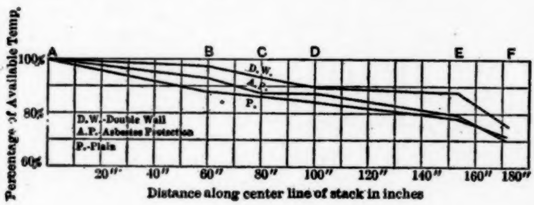


FIG. 1.

the heat loss between the crown of the furnace and boot collar "A." The diagram shows the results of operating the furnace under nearly normal conditions. Higher temperatures in the furnace and pipes produced greater variation in the heat losses.

By reference to Fig. 2, showing the temperatures developed on the outside of the different types of furnace wall pipe, the great

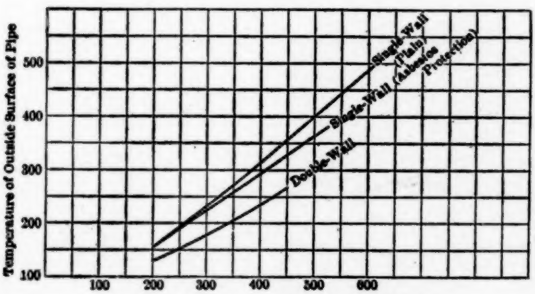
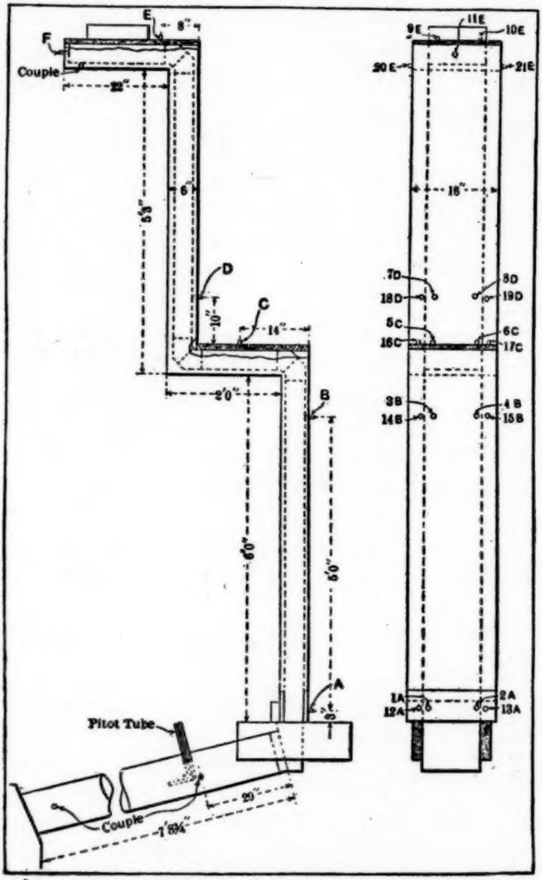


FIG. 2.

heat losses incurred by the installation of single wall pipes in buildings will be seen at a glance. With a temperature of 450 deg. on the inside of the various pipes the temperature of the outside of the single pipe, not wrapped, was 354 deg., that of single pipe, asbestos wrapped, 330 deg., while that of double wall pipe was only 265 deg. showing the remarkably greater ef-

ficiency and lower fire hazard of double wall pipe in comparison with that of single pipe, wrapped and unwrapped.

An analysis of the tests shows the superiority of double wall



DETAILS OF THE TEST STACK

FIG. 3.

pipe at every point and in all particulars. The great loss of heat with single pipe is shown by the very high temperatures developed at the outside at different parts of the pipe. The record shows that at point "A" (see Fig. 3) at the bottom of stack,

single pipe unwrapped produced a temperature on the outside of from 240 to 324 deg., at point "C," where the turn was made, from 234 to 303 deg., and at point "E," close to register, from 240 to 272 deg. The temperatures with single pipe, wrapped with asbestos paper at the different points indicated, are: "A," 228 to 300; "C," 238 to 288, and "E," 196 to 236. Those for double pipe are: "A," 140 to 192; "C," 182 to 210, and "E," 175 to 196, showing a great increase in efficiency, and decrease in fire hazard, in favor of double wall pipe.

One of the vital points involved in these tests has been the demonstration of the greater efficiency of double wall pipe of smaller area in comparison with single wall pipe of larger area, the single pipe installed in the wall in question being 3⅝ in. by 12⅝ in., whereas the double pipe had a cross area of only 3 by 12 in. Notwithstanding an increased area of more than 25 per cent. in favor of single pipe, the latter showed much less efficiency than double wall pipe, due to the very great loss of heat into partitions when single pipe is used. The area of the double pipe tested was 36 sq. in. and of the single pipe 45¾ sq. in.

These tests show the large fuel saving which would accrue to the country through the use of double pipe, owing to the conservation of the heat passing through double pipe, which is not dissipated in the wall. This will often have the effect of turning a furnace failure into a success, where the loss of heat, owing to single pipe, makes it impossible to heat the building successfully.

The use of modern baseboard registers, which are supplanting floor registers in the most progressive sections of the country, will make it imperative, in order to get economical results, to use double stack heads in walls of first as well as of upper floors in installing the new types of baseboard registers.

It may be of interest from an engineering standpoint to note that a temperature of 638 deg. was maintained at the crown of the furnace, and that no damage whatever was done to the same. The steel used in the radiator was No. 14 gauge, open hearth. A velocity of 788 feet per min. was reached during the tests, and air was delivered at this high velocity to the boot at a temperature of more than 500 deg., without injuring in the least the double wall pipe, except at the point where the boot joined the stack, and which was purposely installed without the use of

solder, in order to obtain a test of a connection made in that manner.

These tests will enable us to formulate rules for the installation of double wall pipe in order to insure absolute safety under all conditions. Undoubtedly they will cause the abandonment of the use of single wall pipe in partition walls, owing to the great loss of heat and the increased fire hazard. A third and more important result should be the increase in the rates of insurance charged for buildings equipped with single wall pipe. The fire loss in this country is now in excess of a quarter of a billion dollars yearly, and every effort is being made to reduce this loss. The use of double wall pipe is advocated in the report of the engineers, their conclusions being as follows:

"(a) Single wall furnace pipe as now manufactured is inferior to double wall pipe in all particulars.

> "NOTE: The tests show that it is less efficient in conveying the warm air from the furnace to the rooms to be heated, and that the danger of fire is appreciably greater than with the double wall pipe. Single wall pipe is weak in construction, is easily bent and distorted, is subject to rapid deterioration by rust, and does not afford opportunity for as tight joints between sections as double wall pipe. The loss of heat through the walls of single wall pipe is greater, and the outer surfaces become heated more quickly and attain higher temperatures under the same heat conditions, than double wall pipe.

"(b) Single wall asbestos-covered pipe shows little, if any, superiority over single wall pipe and is inferior to double wall pipe in all particulars.

> "NOTE: The tests show that while it may be slightly more efficient than the single wall pipe, any difference in this respect is slight. The tests also show that the danger of fire is appreciably greater than with the double wall pipe. It is subject to the same structural weaknesses as the single wall pipe, and is probably susceptible to the influence of rust and corrosion to a greater extent. The asbestos covering is reported

as usually torn and damaged in transit, or at the time of installation, and as it is put on by flour paste it is often materially damaged by rats and mice. The thin asbestos paper used has only a slight effect on the transmission of heat through the walls of the furnace pipe.

"(c) Double wall furnace pipe is the most efficient of the three types of pipe as a means of conveying warm air and in consequence has a relatively lower fire hazard. It is structurally superior to the other types and less likely to be imperfectly installed, or to get out of order once properly installed.

"NOTE: The tests show that the loss of heat between the inlet and outlet of the double wall pipe is appreciably less than for the single wall or single wall asbestos-covered pipe, even with a dead air space between the walls of the double wall pipe, as in the tests. With the air between the walls circulating, it is possible that the efficiency of the pipe would be slightly increased up to the point where sufficient heat is dissipated by this means to materially affect the temperature of the air passing through the stack. This is not likely to be a factor with the space between the walls provided in any of the pipe examined. It follows that if the pipe is more efficient, the temperatures of the outside surfaces of the pipe will be lower and the danger of fire will be less in consequence. The two walls of the double wall pipe and the connecting pieces between the walls, provide structural stiffness. The outer wall protects the inner wall from injury and the effect of rust and corrosion, thus increasing its durability to some extent. It is less likely to be imperfectly installed on account of its greater stiffness. The joints used to connect the sections of double wall pipe are more rigid and less likely to be spread apart, when installed, or by the pressure when plaster is applied, than the joints of single wall pipe. As double wall pipe cannot be cut without spoiling it, the pipe must be installed, practically, to exact dimensions, and the machine-made slip joints between sections are less likely to be imperfect. The general principles governing the design of double

wall furnace pipe tend to make the use of this class of pipe less hazardous than single wall or single wall asbestos-covered pipe."

The National Council of the Underwriters have authorized the issuance of the following card as a result of the tests referred to:

"Tests and investigations conducted by the Underwriters' Laboratories, Inc., on single wall, single wall asbestos covered and double wall warm air furnace pipe show that the use of any of these types in connection with warm air furnaces involves an appreciable fire hazard and warrants the utmost care in their installation.

"Double wall furnace pipe is the most efficient and least hazardous, and its use is therefore recommended in preference to the single wall or single wall asbestos-covered pipe."

The installation of the pipe tested was abnormal, the pipe having two square turns and the conditions were the most unfavorable that could be devised. They were purposely made in order to procure the most severe test possible.

The loss of heat between the crown of furnace and the register outlet was approximately 22 per cent. This can be considerably reduced with proper insulation of casing and cellar pipes. We have reached the day of "tested" furnace pipe, and heating engineers have in their possession all data necessary to recommend the best and most economical type of pipe to be used in partition walls. We will soon reach the day of "tested" warm air furnaces, and doubtless a way will be found of cutting down the heat loss between the furnace fire pot and the chimney. The heating engineer should devote a portion of his time and energies to the solution of the problem of fuel waste, and should aid the manufacturer in producing a more efficient heater.

The sanitary side of heating has frequently been discussed and the preponderance of testimony and argument are decidedly in favor of fresh air heating. With proof positive of greater efficiency, which should come within a few months, the maker of furnaces can look to the future with much optimism.

DISCUSSION.

Professor Hoffman: Were there double wall pipes installed between the walls?

Mr. Glessner: There were.

Professor Allen: Referring to Fig. 1, I notice there is a very radical drop in the percentage of available temperature between the points E and F in the horizontal pipe. Is that due to the structure?

Mr. Glessner: You will find that this drop occurs with all the other forms of pipe. The loss in the single forms of pipe was only 11 per cent., and in the double wall pipe it was 22 per cent.

Professor Allen: I refer to the points E and F. The loss on the double wall pipe is much more rapid than on the asbestos protected.

Mr. Glessner: In making these tests the ends of the pipes were also left open, so that the test should be considered from A to E. The heat was distributed beyond the point E. You will notice on the diagram, in Fig. 2, that F is the end of the pipe, and that it was left open in these tests.

CCXLVI.

HEATING AND VENTILATING HIGH SCHOOL BUILDINGS AT DECATUR, ILL.

BY SAMUEL R. LEWIS.
(Member of the Society.)

The object of this paper is to outline the scheme of heating and ventilating a new school-house building in Decatur, Ill., and the remodelling of the heating and ventilating apparatus in an established high school building, together with the scheme followed for supplying both buildings with steam for heating and with electric light and power from a central point. The new building is about 500 ft. distant from the old building, which was formerly heated by ten warm-air furnaces. The ground space for the new building and its surroundings made it desirable to eliminate from it any boiler plant, and the fact that the furnaces in the old building were worn out at the time of the designing of the new building rendered it necessary to install new heating and ventilating apparatus there. The old building is of non-fireproof construction, hence it was proper to remove all fire from within it. The new building was to be completed in the spring of 1911. The old building must be provided with a new plant in the fall of 1909. These considerations prompted the location of the power house adjacent to the old building, especially as coal storage space could be obtained under it, and it would be possible to provide sufficient capacity to supply the old building through the winter at minimum cost.

It was planned to provide the most efficient and economical type of apparatus known, and to ventilate all rooms with at least 30 cu. ft. of air per minute per pupil, and new sanitary ap-

paratus, all of the ventilated type, and power for fan propulsion, lighting and manual training machinery in both buildings. Steam, return and electric conduits were permitted under the streets by special arrangement with the city.

It was decided to install the indirect type of heating, well governed by automatic regulation, as being the most positive and sanitary, as well as economical. Prominent advantages of this system are:

1. It is ordinarily difficult or impossible to hold school without running the fans and securing ventilation.

2. The pupils in a given room are all subjected to the same temperature and some are not overheated, as they must be when direct radiators are placed in the rooms.

3. The trouble and noise of air valves and steam and water circulation in the radiators are eliminated.

4. The false air circulation by direct radiators destroying diffusion of the fresh air is eliminated.

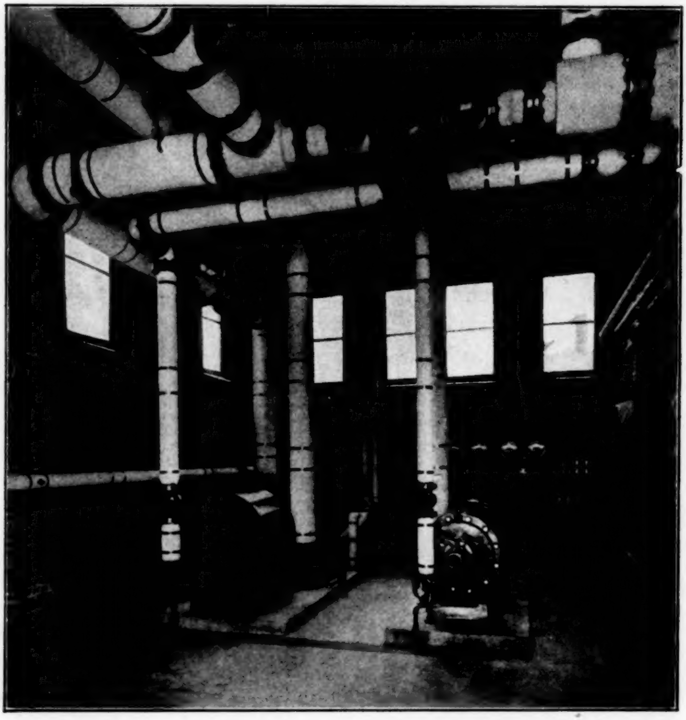
5. The all-indirect plants appear to be more economical of fuel.

The following data may be of interest:

> *Chicago:* Five schools, with both indirect and direct heating, all of about the same size, averaged per cubic foot of space heated and ventilated per season 1.11 lb. of coal. Five other schools of approximately the same size, burning the same kind of coal in the same sort of boilers but having entirely indirect heating averaged per cubic foot of space heated and ventilated per season only 0.67 lb. of coal.
>
> *Kansas City:* The Manual Training High School having both indirect and direct heating cost in fuel, for the year 1909-10, per cubic foot of space heated and ventilated 0.273 cent. The Westport High School, having entirely indirect heating, cost in fuel for the same year per cubic foot of space heated and ventilated 0.124 cent. Both buildings burn oil in similar boilers.

In the Decatur plant direct radiation is used in all toilets, offices, corridors or rooms with plumbing which might be injured by excessive cold. The advantage of having direct radiation in class rooms is that it tends to keep them warm when the

fans are not in operation, provided they are furnished with steam. At Decatur the buildings were arranged in such a manner that it was possible to group the indirect radiation in small chambers near the banks of flues, and thus by gravity air circulation keep the rooms reasonably warm without any direct

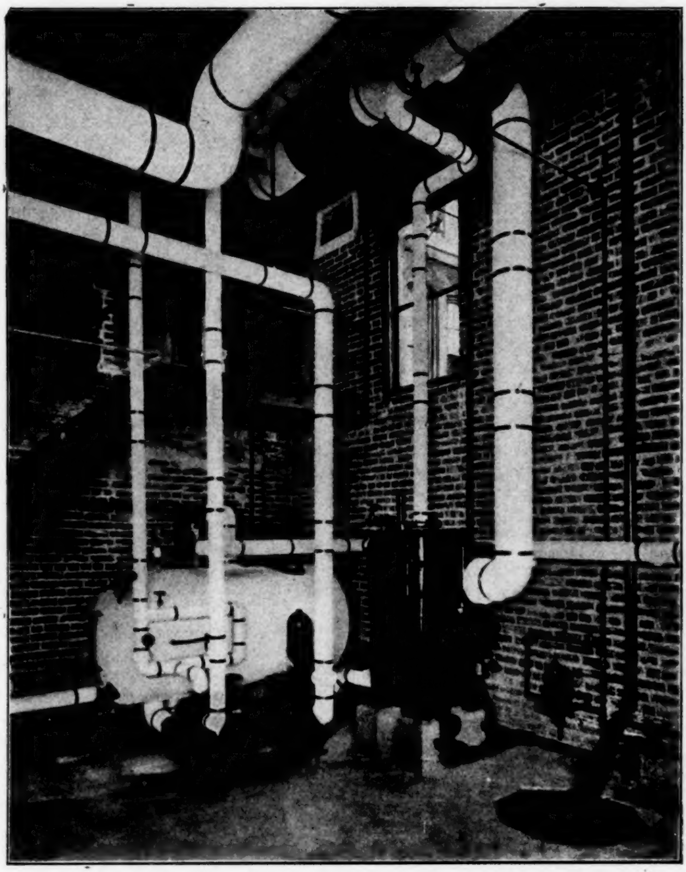


STEAM TURBINES AND PIPING IN THE SCHOOL POWER HOUSE.

radiation when the fans were not in operation. This has proved in practice to work out with remarkable success.

The boiler house is a fireproof building, containing three high-pressure horizontal tubular boilers of 450 rated horse power, with standard equipment for bituminous coal. In a room adjoining the boilers are located the feed-water heater, boiler feed pumps, all main operating valves, pressure regulator, etc., and two horizontal turbine-generators, with the accompanying switchboards. The distribution lines for steam, compressed air and

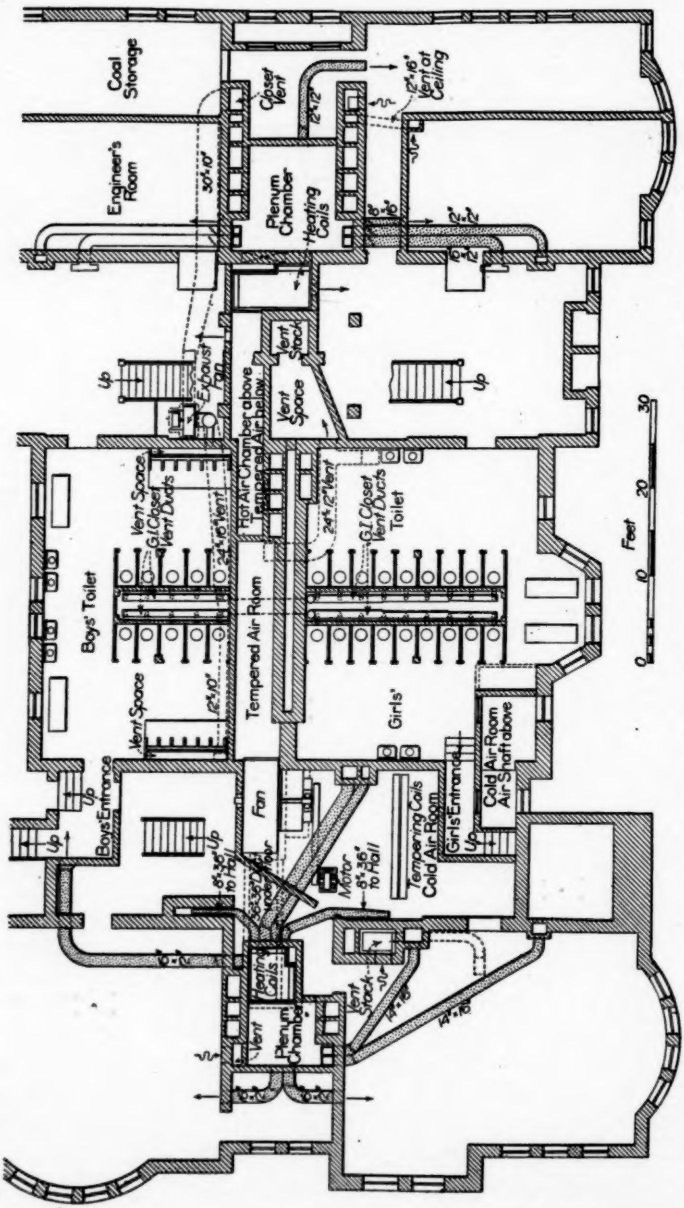
electricity center in this room. The generators are for 250-volt direct current, and one is of 75 kw., the other of 50 kw. capacity. Together they have ample power to carry all of the lights and



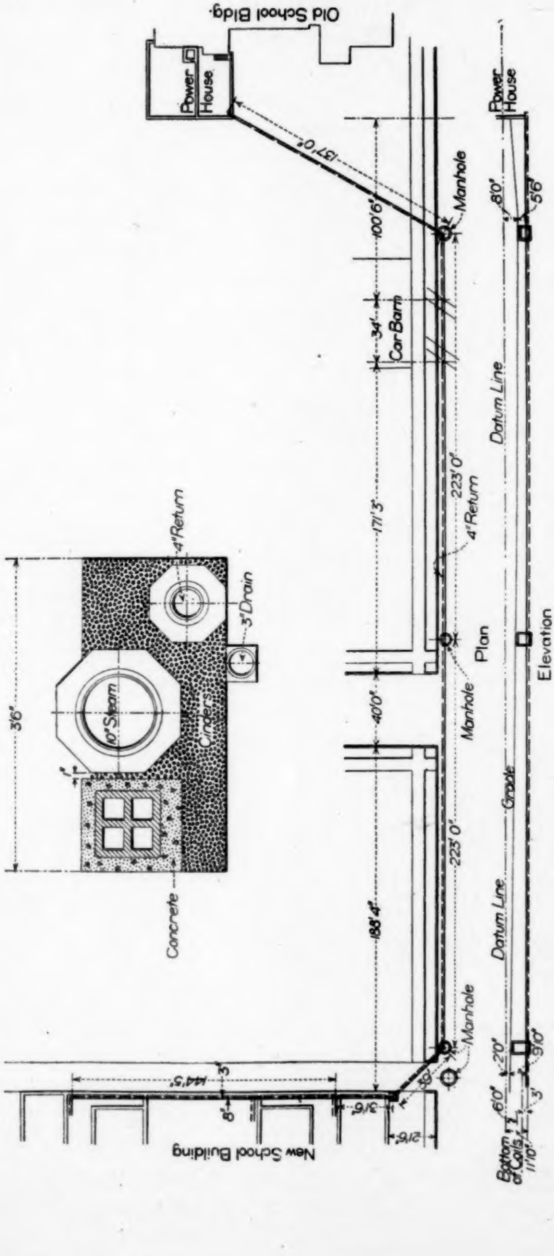
AUXILIARY APPARATUS AND PIPING IN POWER HOUSE.

power in both buildings at one time. In actual practice, however, the peak load never has overtaxed the smaller machine.

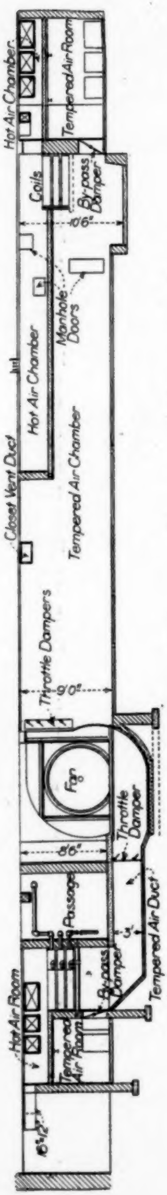
It is admitted that the turbines are not as economical of steam as would be reciprocating engines, but the fact that the plant is in service practically at no time when heat also is not required, and that therefore the electricity is practically a by-product dis-



REMODELED SCHEME OF HEATING AND VENTILATION IN OLD SCHOOL BUILDING.



UNDERGROUND CONDUIT FOR SUPPLYING HEAT AND ELECTRICITY TO THE NEW SCHOOL BUILDING.

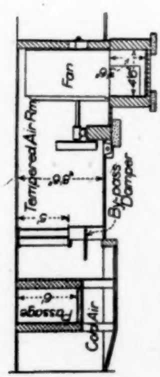


SECTIONAL ELEVATION THROUGH THE REMODELED HEATING AND VENTILATING PLANT.

poses of this argument. The turbines are practically noiseless, have a very long life, require no internal lubrication, thus relieving the boilers of oil, and they occupy very little space. The feed water heater is only 150 h.p., being used merely to purify the make-up water, or to supply one boiler when exhausting to the atmosphere in warm weather, when the plant might be in operation for power or lighting.

To the old building are run a 7-in. steam line and a 2½ in. wet return. To the new building in a common trench, running about 650 ft. and from 4 to 12 ft. underground, are carried a 10 in. steam and a 4 in. wet return, in tin-lined Wyckoff insulation, and a four-part vitrified tile electric conduit, as shown. The main to the new building pitches upward from boiler house, and as it is below the receiver, the condensation in it is raised to the receiver by a tilting trap. Proper expansion joints and anchorages are inserted, the former accessible in brick manholes.

In the old high school the supply fan is a special Sirocco wheel driven by a belted 15-h.p. motor, delivering tempered air to horizontally placed reheating coils in plenum chambers directly at the bases of the flues. Fresh air is drawn from the second-story level. All toilet rooms have special closets, with large rear local vent openings, and all urinals are locally vented, being connected by



AIR PASSAGE TO FAN, OLD BUILDING.

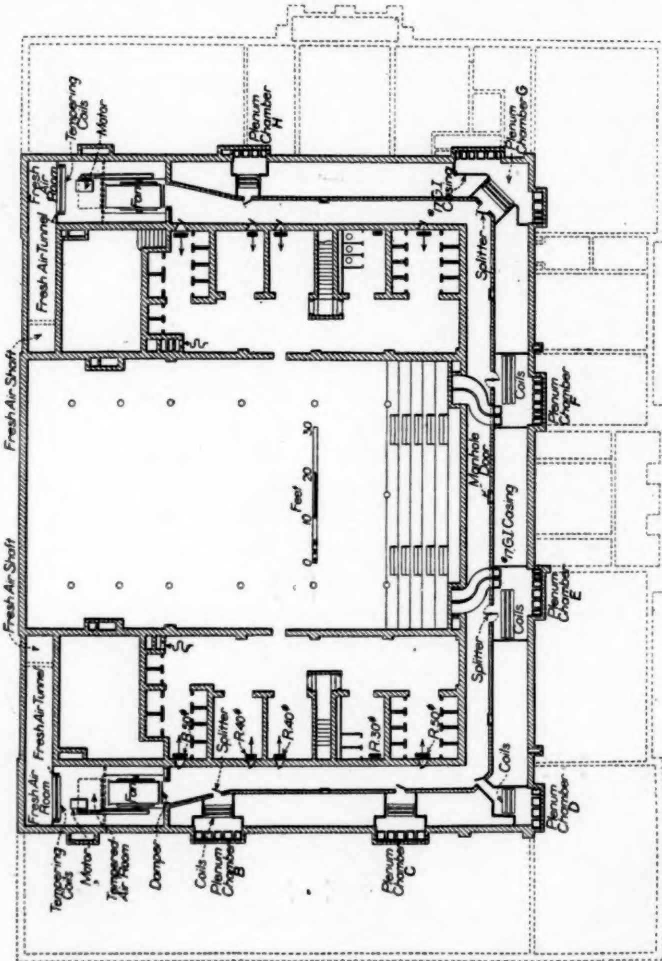
metal ducts with an exhaust fan, which is driven by a direct connected 2½-h.p. motor. New flues of tile supplement the old flues and in the attic are placed cut off dampers in all vent flues for shutting off the ventilation when the building is not occupied. This is effected by compressed air from the engine room.

All class rooms have automatic temperature regulation, the thermostats gradually moving mixing dampers in the plenum chambers without curtailing the volume of air, merely changing its temperature as required. Cumulative devices are installed, by means of which the power of the entire plant finally goes to the slowest room to reach 70 deg. when warming the building in the morning. On all side wall air supply openings are placed adjustable diffusers, by which the air currents may be deflected to any part of each room. There are no vent screens or registers in the new building, the ventilation outlets being finished as far as visible like the rooms, and thus they are swept out every day, preventing the unsightly accumulation of dust, chalk and paper common when screens are used.

The old high school building has an air delivery of 43,000 cu. ft. of air per minute, and about 3,600 sq. ft. of indirect radiation. The air blown into the corridors finds its way out through the toilet rooms, through the locally vented fixtures, and thus there is always a greater air pressure in the former than in the latter, effectually preventing odors from the toilets anywhere in the building. The toilet ventilation is entirely separate from the room ventilation.

The new high school was naturally an easier and more symmetrical problem, but the description of the apparatus in the old building will very nearly suffice for the new one. The fresh air is drawn from the second floor level, tempered and delivered by the fans into a tunnel which extends under the center of the corridor, around three sides of the building. In this tunnel are nine groups of reheating coils and all of the piping for steam and condensation. The tunnel is of ample size for easy inspection, and can be flushed out with a hose. It is well lighted with electricity. It will be noticed that there is very little use of metal duct work. By closing the doors to the various other coils the auditorium or gymnasium may be ventilated or heated by either fan, without affecting the balance of the building. The supply fans are Sirocco wheels in double discharge

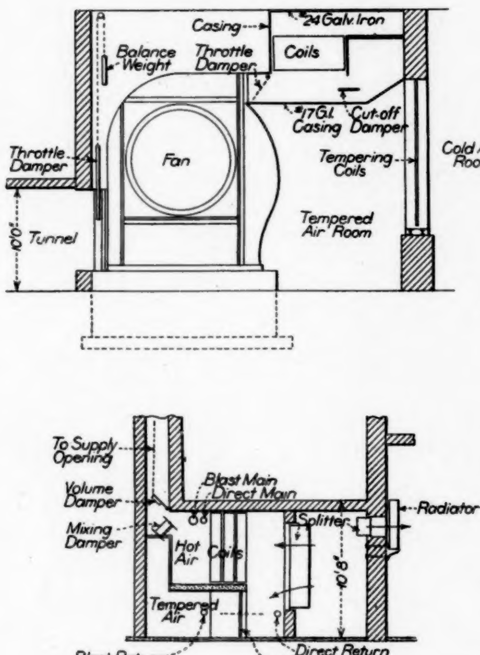
housings propelled by 20 h.p. belted motors. The building receives 120,000 cu. ft. of air per minute, and there are about 9,000 sq. ft. of indirect radiation.



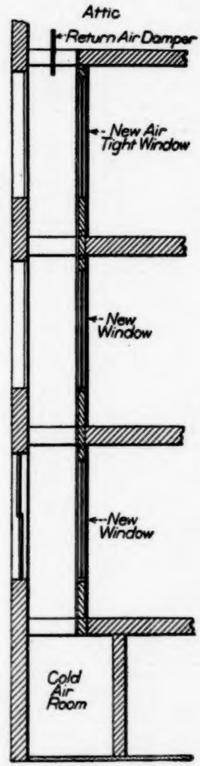
BASEMENT PLAN OF NEW BUILDING SHOWING HEATING AND VENTILATION SCHEME

Exhaust fans for toilet and chemical table ventilation are placed in the attic. Together they have a capacity of 15,000 cu. ft. of air per minute and have 8 h.p. in motors. The chemical laboratory ventilation is carried in vitrified tile pipes, and

the fan which handles the fumes is of special corrosion resisting construction. A large, tight foul-air chamber is formed in the roof space, from which the foul air escapes through ventila-



Details of New Building Plant.



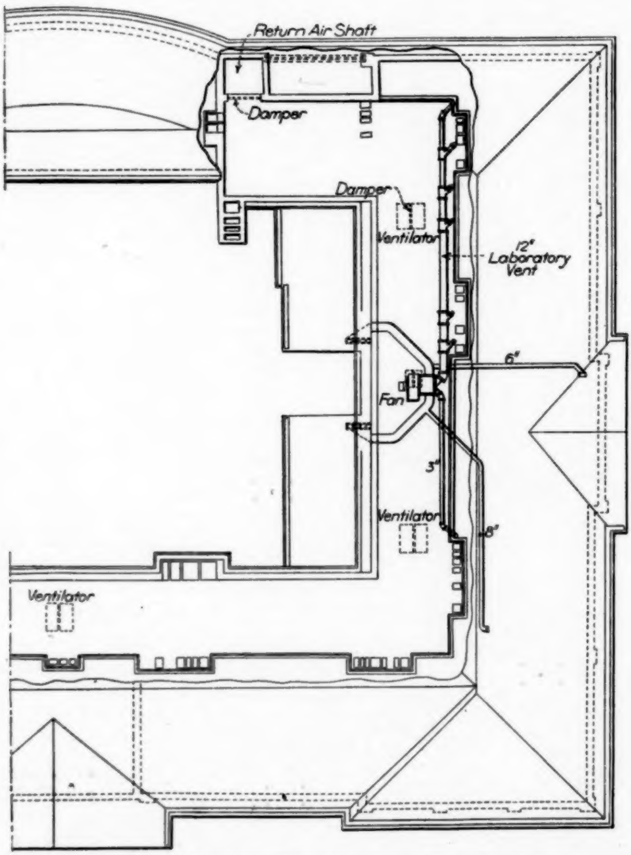
Air Intake, Old Building.

tors, equipped with compressed-air controlled dampers as described for the old building. In both the old and new buildings the foul-air chambers in the attic may be thrown in connection with the fresh-air intake flues, thus forming a closed circuit, through which the air may be recirculated over and over positively, and a substantial fuel saving is thus effected when warming the building prior to occupancy.

Each room has in its supply flue a volume damper, operated from the back of the diffuser in the room, but located in the

inlet to the flue in the basement. This arrangement is of great convenience when adjusting or testing the air distribution, besides eliminating any unauthorized manipulation of the dampers, as is common with the ordinary type.

The locker and shower rooms in the sub-basement of the new building and all corridors have both direct radiation and air



EXHAUST AND RETURN CIRCULATION IN NEW BUILDING.

supply from the indirect system. Whenever possible the air is delivered through or against the direct radiation, thus increasing its efficiency about three times and preventing local circulation.

DISCUSSION.

President Bolton: Gentlemen, we have before us a paper which is of specific interest. It affords a description of the application of modern methods to an old plant, always an interesting problem, because the work that has been done in the past, whatever its merits, must necessarily be improved by the application of more modern knowledge and of better principles of operation. So successful has been the remodeling of the old plant that the new plant may be described in practically the same words as the remodeling of the old.

I was particularly impressed by the author's remark that the difficulty in the use of direct heating combined with ventilating fans is the personal element. Here is the same feature of personal control of the plant, which Mr. Mackay referred to yesterday in his remarks on the care of plants. However desirable the whole combination may be, its operation may fail because of the ignorance, stupidity or laziness of the man who is in charge.

The figures presented by the author, derived from actual instances of heating and ventilating buildings in two cities, are just the kind of data that we all need. We have our own experience that we can match against those figures, and this sort of data will bring into commanding importance in the future the study of economics and of costs of operation.

I observe that the author installed steam turbines in the school power-house. That has also been done in the Stuyvesant High School building in New York City, and the excuse there—for an excuse was needed—was the desire to provide most modern appliance for use and study of students. No other reason was given, and I do not know why the turbine is preferable. The small unit is very far from being a satisfactory steam apparatus. It has inherent defects. The high speed at which it runs, the delicacy of the appliance, almost always require very great care and attention. As an instance, in an office building where three steam turbine generators are in use, on more than one occasion one machine has become stalled and the other machine has reversed it, and driven it as a motor against the steam supply with disastrous results. Owing to the high speed, any comparatively small reduction in speed causes a very considerable drop in voltage; consequently a generator in parallel with another machine may become a motor to drive the rotor against the steam.

With a machine of that kind it is necessary to employ high-priced engineers, and therefore it would seem to be better to use apparatus as simple in character as possible, and well within the knowledge and experience of the ordinary type of engineers usually employed in public buildings.

Another point in the installation is that the electrical system is at the higher tension of two hundred and fifty volts. That probably was due to the operation of the ventilating motors at two hundred and forty volts. Apparently also that voltage is used for the lighting system, which would be extremely uneconomical.

I notice with great interest the simple cumulative device for sending heat into the different parts of the building, prior to the necessity of real ventilation; an excellent and simple scheme, which deserves credit.

The ventilating of the toilets in both these buildings is of a highly desirable character, an arrangement that has been frequently neglected in other buildings with unsatisfactory results.

If the same amount of intelligence were applied to the ventilation of some other classes of buildings as is applied to school buildings, our surroundings would be more comfortable in many of the hotels and business places which we are obliged to frequent.

Mr. Lewis: The electrical distribution is simplified by the fact that very rarely, I suppose once or twice in a year, is it necessary to run both machines. The lighting is on the three wire system, at one hundred and ten volts, and the higher voltage is used for power.

Professor Hoffman: Some mention was made of the personal element. I happened to be in a building this last winter which was heated and ventilated by the split system; that is, a direct radiation heating system and a mechanical blast ventilating system. The cold air duct was boarded up and the fan was re-circulating the air about the building. I was curious to know why the fresh air inlet was boarded up, and asked the janitor. He replied: "Don't you know if we have warm air on the inside and cold air on the outside it will split the coils?" I tried to argue with him that those heating coils were meant for steam on the inside and the coldest air on the outside without injury in the least. His final reply was, "You can't tell me anything like that." This instance shows the perversity of the average janitor.

I would like to inquire of Mr. Lewis how they supported the ventilating fans in the attic without having the jarring from the fans affect the building.

Mr. Lewis: In buildings of fireproof construction the fans are set on wooden timbers of yellow pine. There is no vibration in the new building, as it is of heavy construction. But in the old building the fans are supported on the main bearing wall, and are comparatively small, a twenty-four inch wheel, I think. We have had no trouble from the fans, where the supports are on the bearing wall.

Professor Hoffman: The reason I asked that question was because I know of a building having the fan located in the attic and set upon heavy walls built up from the basement, and yet the vibration from the fan was noticeable around the building.

Mr. Lewis: I think that that would not have happened if both the fan and motor had been properly balanced and the speed not too high. I have had much experience with attic fans and motors and never any serious trouble. Once or twice we have had noise, and have cured it by making the manufacturer give us a better balanced fan.

Mr. Burdick: I was called in one time in a case where a fan was put in the tower of a church on the level of about where the ceiling would be. In that case the fan was set on a wood floor with wooden joists, in practically a drum. By using a heavy thickness of felt, and connecting the fan to the duct with heavy canvas and with the motor set on heavy felt, the motor made more noise than the fan did. In fact the motor made a noise that was heard in the building.

President Bolton: I have had some experience in resting fans upon spring supports by placing the fan framing on light I beams, extended across from a wall to the top of the nearest column; and I succeeded in operating large, high-speed fans on the top of hotels without any trouble on floors below. The spring afforded by the beams is depended upon to absorb any vibratory effect, and with well balanced fans that arrangement has been successful.

Mr. Lewis: This is the time, I think, to tell what the Chicago Ventilation Commission has been doing at the Chicago Normal School in experimenting on school-room ventilation. We were dissatisfied with the air distribution, either in those buildings

equipped as the one I have described, or in those heated by direct radiation and ventilated by air at about 70 deg. We found that the air was not properly distributed unless introduced much warmer than the air in the rooms, when using ordinary inlets and outlets. In order to study the question, an experimental plant was established in the Normal School, with the co-operation of the Chicago Board of Education. A standard class-room has been equipped with a false floor and ceiling, the false floor being raised about 16 in. above the true floor. For every desk there is a 3 in. pipe coming up underneath the book-shelf and ending about 4 in. from the bottom of the shelf. The air is introduced through these openings, some fifty of them, one for each occupant of the room, and taken out into a false ceiling, which communicates with the vent flue. There are four openings for foul air at present in this ceiling. We are going to run that room with normal adult people—as it is a Normal School—they are not little children—and are keeping a careful record of the temperature of the air, its quality and its dust content, using special testing apparatus provided by the Board of Education.

We are also keeping a record of the health of the occupants, the percentage of absences among them, etc. In the course of a year or two we will have very interesting and valuable data, I think. We expect to demonstrate that this is the best way to ventilate a school-room, because often it is necessary to introduce air at a temperature below the temperature of the room; and the old way of bringing the air in at the top and taking it out at the floor does not operate properly when the air that is introduced is cooler than the air in the room.

Professor Hoffman: Mr. Lewis said that it was easier to heat the building in the morning by introducing cool air from the coils than by recirculating. I would like to know what explanation Mr. Lewis has for that.

Mr. Lewis: That is a rather difficult question. I don't know the answer. We *can* heat a building quicker by taking the air from outside. I think it is because we get more air. I never measured it with an anemometer, but it seems reasonable, when we take air in from the outside, through large openings right next to the tempering and heating coils, that there is less resistance and so more air is handled. The humidity of that air is probably about right, also, and this may influence the results.

We get more air, too, because we do not have the friction of pulling it down from the attic through the flues and of circulating it around through the ducts. It is my experience that we can heat a building in about twenty per cent. less time, but we do take more steam.

Professor Hoffman: Has that been true in this one instance or in a number of instances?

Mr. Lewis: My opinion is based on a number of years' experience in many buildings.

Mr. Mackay: I would like to ask Mr. Lewis in regard to the Normal School ventilation if the areas of the ducts are in compliance with the State law, or smaller?

Mr. Lewis: The whole method is figured out on the idea of delivering 30 cu. ft. of air per pupil per min.; but it is our belief that we will get as good ventilation or probably better with 10 cu. ft. of air per pupil per min. doing it that way than with 30 cu. ft. per pupil per min. in the old way. The floor is a temporary construction, and so is the ceiling, and our intention is to change them, enlarge them or make them smaller as developments may require. And coming back to what Dr. Gulick said in New York about the removal of the aerial envelope, by this scheme we spray it right up around each person, in each seat, and get nearly perfect diffusion.

Mr. Collamore: There are a few things that have occurred to me in listening to Mr. Lewis' paper. First, with reference to the five items that he specifically refers to, by which he comes to the conclusion that this form of heating system is best adapted to the heating of a school building. The criticism, that there will be trouble and noise of the air valves where steam and water are used, should not be seriously considered, because it is simply a question of design. A properly designed heating system would not give this trouble.

The question as to the use of the hot-blast system hinges on the temperature of the air delivered into the building. If Mr. Lewis had installed with this system an air washer or some device which would humidify the air, I believe the results obtained would have been much better. My experience with the hot-blast system has been that where no device is used for humidifying the air, even with a room temperature of 70 degrees, the furniture in the room would feel cold on account of the relatively low hu-

midity of the air delivered, and this I believe to be a serious objection to the hot-blast system. That has been one reason why engineers have leaned toward the tempered air proposition so that the air would be of a relatively higher humidity than in the hot-blast system itself. The experiments that Mr. Lewis is making will probably be of great value to us in this connection.

The subject of recirculation of the air is one that has been of interest to us all. In the light of recent information from our medical friends, however, we will have to abandon it, because we are liable in recirculating air, if there are germs and other bacteria injurious to health in the attic or in the flues, to deliver these injurious substances through the rooms. This should be avoided, and the time will come when we will have to make the saving of fuel subordinate to sanitation.

Mr. Lewis: I think Mr. Collamore's points are well taken, and I appreciate very much what he has said. Regarding noise, I appreciate that, when we have a vacuum system, we eliminate all that trouble to a very large extent.

I happened to visit one of the new Cincinnati schools in which are located radiators of 200 sq. ft. surface. While listening to the classes every once in a while I heard the automatic air pressure regulator open up the valves and exhaust the air in the radiator. This was because the steam pressure was carried a little too high, I think. A two-pipe system is installed.

There is no doubt we ought to have more humidity. I tried to install air washers, but the funds would not permit. We can deliver a very fair amount of humidity, at comparatively small expense, by using steam jets in the space for the tempering and reheating coils. That method is being installed as rapidly as possible in the Chicago schools.

Mr. Cones: I tested a building last winter that confirms just what Mr. Lewis has said about heating a building by revolving the air early in the morning. If you revolve the air early in the morning to heat your building, you seem to save fuel; but you can heat your building in just about half as much time if you take your air directly from the outside. The only explanation I can give would be that you get a greater air supply with less restriction from the outside of the building than you do when you revolve your air.

President Bolton: Has not the relative humidity of the air

something to do with that? In other words, in bringing in your fresh supply of air are you not also bringing in a fresh supply of humidity? whereas, if you are circulating what may be described as dried-up air, that is not as effective as properly humidified air. This subject is worthy of further consideration.

Some of our friends who know about vacuum systems ought to discuss this zip noise in the radiator.

Mr. Gifford: Possibly that noise is not entirely due to the vacuum system. If the supply valve is closed at the radiator for a time, it of course leaves the radiator full of steam, which in condensing would pull a considerable vacuum. It might go as high possibly as twenty-three inches, if there is a stoppage at the check valve on the return end of the radiator. So that the condition inside of the radiator when the thermostatic valve opens to readmit the steam is possibly a considerable degree of vacuum and the combination of that condition and a higher operating pressure than a plant should have normally would produce that noise, even if there was not a vacuum system in connection with it, even on a one-pipe system.

President Bolton: There is another very important question, the arrangement of ducts for hot and cold or tempered air; a subject well worthy of discussion and consideration. Perhaps the author would tell us what he did regarding this feature.

Mr. Lewis: I take it, you mean that where a hot-air duct is run some distance in sheet metal and the tempered air duct is adjacent to it, there is liable to be a transfer of heat?

President Bolton: Yes.

Mr. Lewis: It was to avoid that that the coils were placed in subways. The air handled by fans is drawn from the tempering coils and delivered down through the tunnels at, say, 65 deg. The duct between the hot-air pipe and the tempered air that has not been reheated is formed of about four inches of concrete and is about four feet wide. There is no horizontal conveyance of hot air to any appreciable extent. It was not practical to convey two temperatures of air through galvanized air ducts any considerable distance, because the hot air became too cool and the cold air became too hot, as they were so close together.

Mr. Hayward: I think that the principal reason that a building is heated more quickly by taking outside air is that in revolving the air the infiltration is increased, caused by restricted air

returns. Furthermore, when taking air from outside, the difference between the temperature of the air and the temperature of the steam is much greater, and therefore the extraction of heat units from the steam is greater, thereby getting more heat units into the building in a given length of time.

An aggravated case of this kind came to my attention some years ago while in charge of a branch office for one of the blower manufacturers. The building was a planing mill, and when the heating equipment was proportioned, the presence of the shavings exhaust fans, two in number, was entirely forgotten. The heating fan that had been installed had about two-thirds the capacity of the shaving fans, and was figured to draw all its air from the interior. With these three fans drawing air from the inside of a loosely constructed building the result in heating the building can be imagined. The original equipment was taken out and a new one installed with a capacity 50 per cent. greater than the exhaust fans, and by taking all outside air the desired temperature was practically obtained. When air was taken from the interior the temperature was ten deg. lower than when all air was drawn from out of doors. With all three fans drawing air from the inside of the building, the volume handled by the exhaust fans was compelled to infiltrate through natural leakages or to reduce the volume for the heating fan. Naturally a large amount of unwarmed air leaked in and chilled the building. Where the heating fan delivered air in excess of the exhaust fans a slight inward pressure was maintained, preventing infiltration and maintaining a higher temperature.

Professor Hoffman: It is easy enough to see you will get more heat units out of the coils when cold air is used, but you are lifting the temperature of the air from, say, zero to 70 deg. before you have it at the temperature of the room. Of course the coils are doing greater service, but even that point does not explain why it should take less time to heat a room by cold air than by recirculating the air. I do not doubt the truth of the statement that some buildings do heat more quickly with outside air. Where this is the case there must be a restriction in the air line somewhere. You cannot prove such a result on a theoretical basis.

Mr. Collamore: No one has arisen to the question of fact. Mr. Lewis has made a statement that it takes longer to heat this

particular building by recirculating the air than it does by using outside air. My experience has been just the reverse. Perhaps there must be something in the nature and the design of the system itself that brings about this particular fact that Mr. Lewis advances. My own experience has been that where systems for recirculating the air have been used it is possible to heat a building in about half the time that is required when using outside air.

In a system as usually designed for this purpose there are dampers that shut off the fresh-air supply and air exit, so there can be no air taken into the system except that delivered into the rooms. In school buildings, where a recirculating system has been used, when rooms are to be warmed by eight o'clock, even in zero weather, it can be done by starting the plant between half-past six and seven o'clock in the morning; whereas in other buildings of similar size, where the recirculating system has not been provided, it is sometimes necessary to start the plant as early as half-past five in the morning.

Mr. Lewis: I think that the point of fact is well taken. I never tested this building as to the time required to heat it by taking cold air from outside or by recirculating. I assumed that as a general principle, and I think I have never tested a building, where the proper design was made. I have tried to heat a building by recirculating the air, and I venture to say that these other gentlemen, who said it took longer to heat by outside air, attempted to do so by opening the doors. A greater amount of air goes down and goes out through the doors, and never does get into the rooms at all. I am not prepared to say it would take any longer to heat a building by recirculating than the other way.

Mr. Collins: In regard to the fifth statement, that it is cheaper to heat by indirect than by direct, I would like to ask, if the direct radiators were placed at right angles to the wall, would this same conclusion be found?

Mr. Lewis: It would not. If the radiators were placed at right angles to the windows, the cost of heating by direct radiation would be very materially reduced. In the Chicago schools and in the Kansas City schools mentioned there, the radiators are placed under the windows.

CCXLVII.

VENTILATION OF THE MACY STORE, NEW YORK.

BY D. M. QUAY.
(Member of the Society.)

The object of this paper is to describe briefly the ventilating arrangements, particularly of the underground portions, of the department store of R. H. Macy & Co., at Thirty-fourth Street and Broadway, New York City. There is perhaps no better proof of the value of the modern method of ventilation than that applied to those densely occupied spaces of the modern department store necessarily located for commercial reasons below pavement level, where sunlight can never be admitted. The Macy plant has been in use since 1902, and it is felt that the value of the present plant lies very largely in the satisfaction which the installation still gives and the reports in its favor made by officials and managers of departments of the store.

Like the average department store, there is a basement below the ground floor given over to retailing, this level being low enough so that windows and the free circulation of outside air are inadmissible, and below this there is a sub-basement, in this case devoted partly to the mechanical plant of the building and partly to the shipping and delivery departments of the store. In the present case not only are the basement and sub-basement supplied with pure air delivered positively by mechanical means, but an air supply is given to the main floor.

The shipping and delivery departments, incidentally, are equipped with a system of conveyors for carrying packages dropped in chutes to a central point where by means of other conveyors the packages may be sent to elevators to distribute them with respect to the routes to be taken by the different delivery wagons. The department occupies about 74,000 sq. ft. of floor space and is 10 feet high in the clear. As stated, there is no natural light or immediate connection with the outside air. There are about 500 persons employed in the sub-basement department,

making the density of occupation about 1,480 cu. ft. of space per capita. For the maintenance of a healthful and agreeable sub-basement atmosphere, the mechanical ventilating system is depended upon and one indication of the satisfactory operation is the unsolicited statement of the superintendent that numerous applications are on file from employees desirous of being transferred to the department. There is a general opinion expressed to the effect that the air is pure and the atmosphere comfortable and the occasional visitor commonly remarks on how fresh the air seems. It should be further stated that owing to the character and extent of the ventilating system provided and its effect, the Board of Health of New York has issued a permit that boys under 16 yrs. of age and girls under 14 yrs. may be employed in the sub-basement.

The accompanying plan drawing of the sub-basement will assist in showing the scheme of ventilation. The building has three street sides and the fourth wall accommodates some of the elevators of the building and the large fresh air and exhaust flues. The air is taken from a point 225 ft. above the street pavement, and is carried down a shaft 12 x 24 ft. in size. At the sub-basement the air may be passed through underground passages with tempering coils by-passed at will in the usual way and then reaches two pairs of 160-in. steel plate blowers, four in all, which discharge the air through ducts for the supply of the sub-basement, including the engine and machinery rooms, and the basement and the first or main floor.

There are two main fresh-air discharge ducts, one from each pair of blowers. One supplies the north side of the building and is carried under the basement floor. The other is carried along the sub-basement ceiling along the boiler, engine and machinery walls to the east end where it is carried around parallel to the south wall. Finally both are extended to the ceiling of the basement to supply air delivered for reheating coils at the main entrances of which there are three, one at the northeast corner, one in the east centre and one at the southeast corner. The supply of air under the slight pressure serves, of course, to prevent an inrush of cold air with the opening of the doors.

The various fresh-air branch ducts from the main ducts supply the sub-basement and the first story, with reheating coils in connection with each branch duct, except those for the engine, boiler

and other rooms of the mechanical plant which develop more heat than is necessary for warming purposes. The tempering coils and reheaters are regulated by the Johnson system of automatic control. The automatic control of reheaters is of course with the object of regulating the temperature as desired in different parts of the store, each such reheater being under the control of a separate thermostat.

The basement and first story have their most crowded occupation toward the central portion, and with this point in mind the system was designed in connection with these floors to deliver the air to the central parts instead of to points along the outside walls. This was accomplished by placing grills on the fronts of the counters carrying the branch ducts on the ceiling below, alongside the deep girders, to outlets in the counter fronts. The air risers are marked A on sub-basement plan. In the stove and household goods department in the basement, however, large registers were placed in the floor in an out-of-the-way place, as there are no permanent counters in this section of the department store.

A mechanical exhausting system is also provided, this removing the vitiated air from the boiler, engine and machinery rooms, from the shipping and delivery departments, from the toilet and locker rooms and from the kitchen, laundry, bakery, etc., on the eighth floor of the building. No air is blown into the toilet rooms except one large room in the basement. In this case about two-thirds as much air is blown in as is drawn from the room, so there is always a slight suction in all the toilet rooms to prevent an uncontrolled escape from such rooms to other parts of the building.

For handling the exhaust air there are two 10 x 10 ft. air shafts at the rear wall and the space around the chimney is also used to assist in the exhaust system. These are fitted with fans and there is also a 12-ft. exhaust fan located near the ceiling of the engine room. This draws air from the engine and machinery room and discharges it through a 12 x 12-ft. grating to the outside atmosphere. A 120-in. steel plate exhauster at the rear of the boiler room draws air from the boiler and pump rooms and discharges it into one of the exhaust shafts.

An interesting detail developed in connection with the power required for driving the fresh-air blowers. So great was the

chimney effect of the lofty down-take shaft through which the air had to be brought from above the roof that motors had to be selected of about 25 per cent. greater horse power than would normally suffice.

A recent test made by the chief engineer of the building with thermometers placed at different points on the fifth floor, a large open space with numerous windows, and also in the shipping department of the sub-basement, showed less than two degrees difference in temperature on the two floors. It was his opinion that the air in the sub-basement was as pure as the outside air, and that it was in constant motion in all parts of the floor. Finally there is no complaint of drafts.

The foregoing of course deals with only a portion of the heating and ventilating plant. The building is heated by direct radiation, of which there are 62,000 sq. ft. The building itself incloses no less than 16,000,000 cu. ft. of space. There are 12,960 lin. ft. of tempering coil surface and 7,000 sq. ft. of indirect radiation in heaters. There are 3,020 h.p. in the boiler plant and in the mechanical plant there are four 500-h.p. and two 300-h.p. electric lighting units, 32 hydraulic elevators, a 25-ton refrigerating and water-cooling system forming a part of the plant. Some of the other apparatus making a power demand on the plant are four escalators or moving stairways, the parcel delivery and conveyor systems mentioned and a vacuum cleaning system. The plant also includes a garbage and refuse destructor.

DISCUSSION.

President Bolton: This paper describes the application of a ventilating system to a very different sort of building than that described in our previous paper, and brings up before our minds another method of accomplishing similarly desirable results. Here the tempered air is blown to reheating coils located at the end of branch ducts, and in other cases in the sub-basement, where reheating is not required, the tempered air is blown directly into the space to be ventilated. There are two sets of fans of equal power discharging to the south and north side of the store; the passages on the south side, the upper portion of the diagram, being much more tortuous and longer than on the northerly side or bottom of the diagram. That result was brought

about by individual drives of the fan, and the balance of pressure is easily controlled by variation of the motor speeds.

Mr. Davis: In regard to sub-basement ventilation in Chicago there is considerable discussion going on now between the contractors, engineers and the city authorities. In one hotel here, the Sherman house, it was planned that there should be sleeping quarters for the engineers and some of the help in the sub-basement. The authorities would not permit this, although it was proven that the ventilation was good. Mr. Soule knows something about this subject, which would be interesting to the members.

Mr. Soule: I do not know that I have read about the providing of ventilation for those sleeping quarters, but I know of one plant in Chicago, where for the basement ventilation of a department store fresh air was introduced on one side entirely, and blown across the room, all the exhaust being taken out on the other side. If the right proportions are used, that is a very good method to use.

President Bolton: Are both the intake and the exhaust high up in the basement?

Mr. Soule: Yes.

President Bolton: Well up toward the ceiling?

Mr. Soule: Fresh air is introduced near the ceiling and the exhaust is taken out on the opposite side of the room. I believe that the room was about sixty feet wide.

Professor Allen: There is one difficulty I have met in sub-basement ventilation, the fact that the air increases in temperature after passing any great distance into the room. When first installed and taking the air in at the ceiling at 65 deg., then letting it pass the full length of the room, then exhausting it from a kitchen, going a length of 75 ft., we found that in passing that distance the temperature was increased 5 or 6 deg., and in extreme cases as much as 8 deg. We had to make a change in our plant and introduce air at the opposite end of the room in order to overcome the difficulty. The wall structure carried heat and it was necessary to admit colder air than that in the room in order to keep the air at a comfortable temperature throughout the entire space.

In this sub-basement the subject of vent or eduction is not fully described. The question of removing heated air from en-

gine rooms is one that comes before all of us some time or other. It presents peculiarly varying problems, because of the point to which Professor Allen has drawn attention, namely, that the introduction of air into an engine room is of little value, since it becomes heated up almost immediately, and such a supply must be supplemented by vent fans.

I had recently to ventilate an engine room, in a large hotel in New York, in which the temperature in the summer time was as high as 145 deg. It was reduced to 110 deg. by taking out the fresh air supply blower, and reconnecting it as a vent, supplementing the exhaust fan. The fresh air was allowed to find its way in naturally through the same opening, through which the fresh supply had presumably been drawn. There was not any value in the forced supply of fresh air. The object was to get the heated air out of the room, and let the fresh air find its own way in, which method proved so effective as to reduce the temperature 35 deg.

Mr. Soule: I know of one boiler room here in Chicago where the hot air is taken from the top of the boilers through ducts and is carried to the fans which discharge the air underneath the boilers through Jones stokers. That is a very good way of decreasing the temperature of the air, so that the heat will not affect the first floor.

President Bolton: That is also being done very satisfactorily in the Ellicott Square Building in Buffalo.

Mr. Soule: I should say that a fresh-air fan supplies air to this boiler room for the firemen.

President Bolton: Is the air circulated across the boiler room?

Mr. Soule: Yes.

CCXLVIII.

STREET CAR VENTILATION.

BY W. THORN.*

The subject of street car ventilation has perhaps not received the attention from street railway companies that its importance demands. This has resulted from the lack of thorough information and inability to find practical apparatus or equipment for the purpose other than the usual means, rather than any unwillingness on the part of the management of these properties to provide for the proper ventilation of their cars.

The usual method of obtaining ventilation in street cars has been to provide a monitor deck or clear-story in which are a number of small windows that can be opened and thus give a certain amount of ventilation. Nearly all cars have been built in this manner. The ventilation afforded by these small windows is largely by dilution, that is, such air as may enter these windows serves to freshen the air in the car. It is very doubtful, however, if this action extends far enough down into the car body to provide reasonably fresh air in the so-called "breathing zone." Furthermore, attempts to bring in enough air so that the fresh air is available in the breathing zone almost invariably result in strong drafts which are very objectionable to passengers.

The monitor window method of ventilation has been generally considered adequate. Studies made of this method of ventilation, however, show that it is almost impossible to accomplish good results without the presence of strong drafts and chilling of the air in the car below the proper temperature.

These considerations, together with the increasing interest of the public in better service, have resulted in much attention being given to this subject by operating companies and engineers.

The problem of providing adequate ventilation in a street car is not one easy of solution. The difficulties arise from several

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causes, among which may be mentioned the comparatively small capacity of a car body in which many people are carried, also the various desires and whims of passengers as to proper ventilation and the necessity for preventing drafts and chilling the air below the temperature required by the authorities.

The need for better ventilation than that afforded by the monitor or deck windows is much greater with modern pay-as-you-enter cars than with the double-end type of cars, which have both platforms open on one side to the air. This results from the fact that the front platform on the pay-as-you-enter cars is closed while on the other cars it is open; therefore, the air cannot circulate so freely through the pay-as-you-enter car as through the double-entrance type when stops are made and the doors are opened to take on or discharge passengers.

To meet the need for better car ventilation several devices have been developed and are now on the market. The designers of some of these devices recognize that heating and ventilation should go together and have worked out their apparatus with this end in view. These ventilating devices or systems consist of two general types: first, those which depend upon the speed of the car for their operation. All such devices work on the aspirator principle. Second, are those systems which use mechanical means for circulation of the air and are practically independent of the speed of the car. Mechanical systems of both the exhauster and blower principle have been brought out.

Authorities differ as to the amount of air to be supplied per person per hour in order to provide adequate ventilation. An ordinance of the city of Chicago requires that in the ventilation of street cars not less than 350 cu. ft. of air per hour per passenger (based on maximum seated and standing load) shall be supplied, provided, however, that the carbon dioxide shall not exceed 10 parts in 10,000 parts of the air in the car. The 350 cu. ft. of air per hour per passenger shall be brought in through the openings or intakes provided for the purpose. There will also come into the car through cracks, crevices and the opening of doors a considerable volume of air. The ordinance further provides that the air for ventilation shall be brought into the car below the average level of the heads of the seated passengers and be taken out above the heads of the standing passengers, and that the intakes be so constructed as to exclude dust. It also pro-

vides that there shall be maintained within a car an average temperature not lower than 50 deg. F.

There have been several ventilating systems tried out in Chicago, both the mechanical and automatic type, which are designed on the basis of the above outlined ordinance. Several hundred cars have been equipped with such ventilating systems.

A brief description of typical systems may be of interest: The mechanical system consists of a motor-driven exhaust fan located on the vestibule roof, an exhaust chamber formed in the upper ceiling of the car, openings located at various points in the ceiling, and intakes located at several points in the floor and connected to the electric heaters. The fan-motor set consists of a very generously designed ½-h.p. motor direct connected to a specially designed 9-in. cone fan. This fan will handle about 33,000 cu. ft. of air per hour under normal conditions of line voltage. The motor is connected direct to the 500-volt trolley circuit through a standard combination snap switch and fuse, and is started and stopped by means of this switch. The motor and fan are mounted in a suitable metal housing, which is connected to the exhaust chamber. The fan discharges through protected openings in each side of the housing.

The exhaust chamber in the upper part of the car is formed by dropping down the ceiling about 4 in. from the roof framing and is continuous from end to end of the car body. Communication between the car interior and the exhaust chamber is provided by 14 openings, each containing a circular adjustable register. By proper adjustment of the registers, a uniform velocity of air through all of them is obtained. The intakes are 8 in number, four being located on each side of the car, under the seats in such a manner as to be readily connected to the electric heaters. The connection between the screened opening through the car floor and the electric heater is made with a pressed metal duct. The size and number of the intakes are such as to permit of a maximum velocity of the air of about 400 ft. per minute, which is hardly perceptible to passengers.

The automatic systems installed are of several different kinds, but all depend upon aspirator action for their operation. One of these automatic systems, which has shown good results, comprises a number of "exhausters" located along each side of the monitor roof and attached to panels placed in the monitor or

deck window openings. An opening in the panel communicates with the "exhauster." Intakes similar to those described in connection with the mechanical system are located in the floor and provide for a supply of fresh air. The "exhausters" are rectangular sheet metal boxes projecting outwardly from the panels to which they are secured, having openings top and bottom, and provided on the middle of each side face with V-shaped projections. The V projections are placed horizontally on the faces of the exhausters and "split" the air into two streams, one flowing upward and the other downward. The air streams flow past the openings of the exhauster and by induction "draw" the air out from the car.

The impression has generally prevailed that thorough ventilation could not be effected without increasing the amount of energy used for the heating of the car. Experience with the deck window method of ventilation in which the heating and ventilating systems are not closely related is undoubtedly responsible for this impression. Tests conducted on street cars with ventilating systems, such as have been described, where the air in coming into the car passes first over the heating units and then is drawn up through the car and taken out at the top, demonstrate, however, that it is entirely possible to heat a car to substantially the same temperature with this system as when the deck window method is used, and with no greater expenditure of energy. We believe the reason for this lies in the greater efficiency of the heating units when working upon a continuous flow of fresh air passing over the heating surface as against the ordinary practice of placing the heating units in practically a dead air space where a considerable amount of the heating energy is lost in raising the temperature of surrounding parts of the car, such as the seats and the adjacent woodwork.

Tests made on both the mechanical and the so-called automatic systems show that it is possible to provide an air change in the cars about every three minutes, and this without the presence of objectionable drafts or the need of any more than the usual amount of energy for heating purposes.

In the light of experience with ventilating systems of the kind described, it can hardly be said that it is impossible to find practical means for the ventilation of a street car which will answer every reasonable requirement.

DISCUSSION.

The President: We have a paper here that is of interest to almost every one, both within and without the ranks of the membership of the Society. We do not all of us go to school and many of us cannot stay in hotels all our lives. Some of us have to inhabit unventilated business buildings, and to live in unventilated apartment houses. However, we all have to ride in street cars, and of all foul places the average street car may be conceded to take a front rank. This paper, if it accomplishes nothing else, shows that the public is taking an interest in the question of ventilation, because it is only as a result of public demand that the railroad companies will go to the expense of even testing and trying different ventilating systems.

One of our members has observed that on certain lines in this city, where the cars run for considerable distances, the air becomes extremely foul. He has actually seen many instances where waiting passengers will allow those cars to pass, although they go in the same direction as they desire to travel, and will wait to take a car which makes shorter runs, and is therefore less foul. Now insensibly those people, whether they realize it or not, are helping to bring about proper ventilation of public vehicles, a very important and widespread subject which affects not merely the street cars but the growing number of subway cars.

I regret that I have not brought with me statistics as to the subway in New York. I believe I am right in saying that the average space occupied by a passenger in these cars does not exceed 80 cu. ft., and it is easy to see how soon a limited space like that will become fouled with exhalations from other passengers, crowded as they are in the ordinary traffic of that railroad. The amount of air supply required by the Chicago ordinance, 350 cu. ft. per passenger, would effect about four changes of air in a car per hour, which is very moderate, and yet might be sufficient.

We have had in New York a great deal of discussion regarding the lack of ventilation in the subway cars. An elaborate and expensive system of ventilation of the tunnel was installed at the expense of the city, but no attempt whatever was made to improve the ventilation of the interior of the cars. Recently, however, there have been inserted in some of the cars wide-bladed

fans driven by a direct connected vertical motor, suspended on the ceiling of the car, four to each car. These produce a pleasant down-draft and agitation of the air in the car itself. They do not provide ventilation, but merely air movement.

So that the art of car ventilation does not seem to have advanced very far in other parts of the country, certainly not in the metropolis. It appears in this paper that Chicago is getting ahead and it behooves us to wake up in the east.

Mr. Natkin: I had occasion last year to discuss car ventilation with an engineer who was employed by the Chicago Elevated Railroad. It had been the custom of the railway to run four or five cars in a train, with a smoker as the last car. This engineer made a number of tests for carbon dioxide in the various cars, particularly on the express service. In mornings and evenings express cars run from 43d Street to the Loop, a distance of about five miles, making the distance in about eleven minutes, and he found that the carbon-dioxide increased about 100 per cent. in all the cars, especially the smoker, where it increased 200 or 300 per cent. by the time it reached the Loop, which made the smoker very objectionable. The reason for placing the smoker at the rear was to prevent the smoke entering the other cars. They then tried the experiment of putting the smoker as the first car, figuring that it would get more ventilation, due to the speed of the train; and they found it reduced the carbon dioxide quite materially. After that they attached ventilators to the bottom of the car, a sort of V-shaped projector, about five on each side of the car. By placing the smoker ahead, and with the assistance of these ventilators placed on the bottom, they are able to reduce the pollution, so that the increase of CO_2 is not over 50 per cent. over that when the car is empty. I frequently come down in these cars in the morning, and the ride in the smoker is not nearly as objectionable as it was a few years ago under the old conditions. The engineer also said that the railway was experimenting further on these cars, endeavoring to find a still better solution of ventilation.

Mr. Kirk: I would like to ask Mr. Natkin if any test was made of the condition of the last car of the train after the smoker had been put forward.

Mr. Natkin: If I recall correctly the location of the car did not make any difference, except that the first car always had bet-

ter ventilation than the rear car. For that reason they usually make the smoker the first car on the train.

President Bolton: Were they vestibule cars or the open platform type?

Mr. Natkin: They are of the open platform type. The doors are closed when the cars leave 43d Street, and are not opened again until they get to the Loop, about a ten or twelve minute trip, and sometimes fifteen minutes.

The President: Does any Chicago member know what is being done by way of experiment with these cars at the present time? Do you know, Mr. Natkin, whether any of the cars described in this paper are now in regular operation?

Mr. Natkin: These new cars, which have been recently built by the Pullman Company, were installed on the 12th Street line, on which a great percentage of the passengers are of the laboring class. I had occasion to ride on that line when the old cars were in service, and they were very foul smelling at all times, particularly in the evening and morning. I have also traveled in the newer cars and the improvement is readily noticed. While the air is not as pure as we get on some of our north side or south side transportation lines, there is a great improvement over the old cars. There is an exhaust system on these cars, with the ceiling dropped about four inches and equipped with registers. Riding is much more comfortable on these cars than when there was practically no ventilation at all.

Mr. Lewis: I think there are several ventilated cars now in operation. Nearly all that run on Madison Street are ventilated in that way, because the law compels ventilation of all new cars.

Mr. Soule: The Chicago Railways Company gave the Vacuum Car Ventilating Company an order to equip 350 cars. Quite a number of them are running on this system, which has a fan in the roof, and draws air in through the heater under the seats and exhausts air through registers in the top of the car in the false ceiling.

Mr. Lewis: I believe that nearly all the cars in Cleveland are now ventilated. The success of car ventilation in Chicago has led to great interest in the subject all over the country.

CCXLIX.

TOPICAL DISCUSSIONS.

TOPIC NO. I.

"Operation and Care of Heating and Ventilating Apparatus."

Mr. Mackay: Mr. President, it is presumed that the larger mechanical plants will receive proper care and attention in their operation, for the reason that there is usually a person who is made responsible for the operation of the apparatus. Sometimes there is a competent man, who is faithful to his duty, and then the results, that are intended and expected from the apparatus, are obtained. On the other hand, in some of the larger plants, which are operated through politics, men are appointed who are perhaps incompetent, and lack previous experience with the apparatus, being attracted by the remuneration. As a result, poor operation condemns that particular plant, when, if properly handled, it would give the result that the designer intended.

A large number of domestic plants, installed in this country, as a general thing do not receive the care that the larger plants do. We sell from 75,000 to 100,000 heating boilers in this country every year, and it is safe to assume that perhaps 75 per cent. of them are placed in the hands of those who do not know how to use them properly and who frequently operate them in disregard to the manufacturers' printed instructions.

I know of many instances where people say that the trouble with their furnaces, or steam, or hot-water heaters, is that they will not raise the temperature quickly enough in the morning. Now that may be due to the size of the apparatus or something else; but I find in general that it is the result of the way in which the apparatus is run. These operators who do not get the heat quickly enough start in the morning with a building at, say, 50 deg. and by night time will have raised the temperature in eight or ten hours, to 80 deg. From this showing, in the face of cold weather it would appear that the apparatus is admirable;

but the method of operation is wrong in that they allow a fluctuation of temperature of perhaps 30 or 40 deg. in twenty-four hours.

Now the greenhouse men teach us a lesson in heating. They are working with a material that is more sensitive than a human being. A plant will not thrive in a variation of five deg., and as a result these greenhouse men, in addition to putting in the best apparatus, have skilled watchmen sitting up every night with the fires. They only fire during the night, and bank the fire and burn no coal during the daytime, unless they happen to have a cloudy day. The result is a uniform temperature within 5 deg.

It takes more coal to raise the temperature than it does to maintain it, and as a result the apparatus is often blamed for an excess consumption of fuel, that is due altogether to the mistakes of the operator, to want of care and cleanliness.

In a certain church building they have been getting poorer results each year, and on investigation I found that some of the indirect radiators, which were metal castings below the floors, were completely filled with dirt and dust. The only air that could get up into the church building was around the outside of the stack. The entire center was covered with stuff that might look like hair, felt or manure, and that was being cooked during the entire winter and served up to the people above.

The same thing happens in the private house, where they sweep the house without covering over the floor registers with a mat or something to keep the dust from going down into the register.

President Bolton: Illustrative of what Mr. Mackay has said is an instance in my own domestic circle. I have one of these indefensible floor registers in a room, and frequent complaints are made that that room is not heated properly. I discovered the cause in the domestic cat, which evidently has found that register the warmest place to lie upon, and succeeds in blocking off the entire air supply. The room is cold all night long, but the cat is warm. These are days in which such questions are close to everybody's heart. We are all trying to economize.

Prof. Allen: As to the effect of heating at night or allowing a building to become cold at night, we had an opportunity this last winter to experiment with that condition at the University

of Michigan, where we burn about one hundred tons of coal a day. We tried to find whether it would be more economical to let the buildings go cold on Saturday afternoon and warm up on Monday morning, or to keep them heated during the entire period. Our result shows that it took about a ton more coal to keep them warm than to allow them to go cold, and we concluded it was very much better to keep the buildings warm.

Mr. Davis: I would like some of our members to tell us what experience they have had with the Chicago schools in the same way over Sunday?

Mr. Patterson: I would say, in answer to Mr. Davis' question, that we have a bulletin calling the engineer's attention to the fact that he will be required to have the building in proper condition on Monday morning, and where severe weather sets in during Saturday or Sunday (usually the first severe spell occurs either upon Saturday or Sunday), he must at once visit his building and generate steam and run the apparatus. We have many kinds of installations, but with a modern plant there are very few engineers that attempt to run the system over night. On some Sundays and occasionally on Saturday they start up the engines and run sufficiently long to be certain that the building will not grow cold enough to cause any damage; otherwise they get there early Monday morning. With some of the old style direct plants they sit up practically all of Sunday night in the very severe weather. With the modern systems we do not have much trouble and do not order them to run at night.

Speaking to the paper, which I understand concerns the character of the apparatus, I think in the majority of the large cities and public corporations the spirit of civil service is entering thoroughly. In this city efficiency, as has been determined by the Chicago Civil Service Board, is thoroughly insisted upon. The methods, by which efficiency may be determined, are such that the character of the apparatus and the man's ability to grasp the uses of the different portions to obtain the best service from them will be factors that will count in his promotion. In the various examinations which are held, the most of the questions are based upon a man's ability to handle his apparatus and to save money in the care of it. I think that the results in all of our larger cities are satisfactory. Recently the county has introduced a similar civil service system.

Mr. Weinshank: To endorse the statement made by Professor Allen, I will state that in designing plants in which intermittent heat is to be used, I invariably increase the radiation about thirty per cent. over the amount required. The fuel consumption in such plants is in direct ratio to the additional radiation so designed.

There were two churches, within a block of one another; both had about the same cubical contents and about the same exposures. After a season's operation the fuel burned in the Protestant church was about 25 to 35 per cent. more than in the Catholic church. In the latter steam was kept up day and night the entire season. In the Protestant church heat was turned on only two or three days in the week and on special meeting nights.

I usually advise owners that it is cheaper to keep up steam day and night during the entire season than to heat the building intermittently. Some people are rather skeptical in believing these statements, but after a due trial become convinced. The wear and tear on a heating apparatus is greater when used intermittently than when operated constantly.

Mr. Tait: About the hardest thing a heating engineer can do is to convince a man that it is cheaper, on a job of any size, to fire seven days in a week than to fire two or three days. It is cheaper, there is no question about it.

The President: I have had this question of the desirability of allowing the temperature to fall in a large office building, come up in a dozen cases. There is a great diversity of opinion among manufacturers, who seem to be at sea as to results. I hope this winter to run some test or experiments and obtain definite information.

I will mention an instance, perhaps an extraordinary one, of the neglect of good apparatus, after installation, in a prison in the State of New York, in which six hundred persons were confined. Direct radiation was provided throughout, and a complete system of forced ventilation. Examination showed that the motors of the ventilating apparatus were out of service and covered with dust, indicating long disuse. On making inquiry I learned that no portion of the system had been in operation for two years. Such conditions indicate that proper attention and care are not given to operation by some New York officials,

and we hope that the improved conditions, in the conduct of official services in the West, may extend to the East.

Mr. Mackay: In one of our eastern cities is a large post office building, designed at Washington, and intended to be as good a plant as could be obtained. The fan and engine were never operated after they had been installed. Air was obtained by gravity. There was no real complaint for a year or two, then they found that the air was positively foul in the building and was affecting the health of the men who were working there. The inspector, who was a member of this society, came on from Washington to examine the trouble. He found that a room, about eight or ten feet wide by fifteen feet long, with three windows, which was the intake for pure air, had been utilized as a workshop by an electrician. The postmaster took him down into the basement and gave him this space. He had put a workbench across the three windows and closed them. They were getting no air into that building, except the leakages around the doors and windows. All the entering air was cut off by closing those three windows.

In a well designed hospital building, that lacked air, we found that the cold air entrance or tunnel, from the ceiling to the floor, was made a receptacle for barrels, boxes and other things brought into that building. Every time they put an obstacle in the space they reduced the air supply, until finally the area was about 25 per cent. of what was required by the designers. This lack of care causes the condemning of efficient apparatus. If competent men should operate the plants as they are intended, the results would almost invariably be those that are desired.

TOPIC NO. 2.

"Reluctance to Divulge Alleged Secrets in Relation to Engineering Progress."

Secretary Macon: I have noticed that this question is one of those things that comes up at intervals, and recently the president of the Society of Automobile Engineers in his address talked at length on the subject, as did also Dr. Henry H. Howe, president of the American Society for Testing Materials.

You will agree that usually the man who divulges the most has the most in store, and certainly it is phenomenal that the

more we give up the more we have. Some people enlarge our mine of information.

Mr. Mackay: When the Society was first organized and we were looking for members, some were not in favor of joining, for they thought they knew more than some of the others, and that if they came into the Society they would have to divulge their knowledge and their business secrets. That was the thought of a few, whom we might perhaps term selfish individuals. But one of the things that makes the meetings so interesting to our members and their guests, and makes them look forward to coming again, is the fact that the individual members of the Society have given their best thought and their best judgment freely, with the result of not only building up the Society, but also of building up the business or occupation of the party who has given the information. The one who has given the most has received the most. In the course of seventeen years I have not heard a single complaint from any member, that he has given something to the members and to the public through this Society and has been injured by it.

Mr. Monnett: A little while ago heating of high buildings was discussed. Your President had some interesting information on that topic, which he had been gathering for some time. I recently met a gentleman, who had made the same kind of investigation, and had come to similar results. In working over some of the data to publish I was told that the matter could not be given out, that it was strictly his own and probably had not been observed by any other engineer in the United States. I did not tell him at that time, and I am in doubt if he realizes it yet, that the information is known by at least one engineer and possibly by others. The man who thinks he has exclusive information very often has not. The expression of the idea confirms other people's views and supports and gives general publicity to the work.

Mr. Hale: My experience with the members of the Illinois chapter is that they have all been very glad and willing to give all the information they could in the meetings and elsewhere on any engineering subject that might come up. I have rarely seen any inclination to hold back information, except perhaps certain rules that were rules of thumb, which they had followed, and did not care to give to the public, because they could not

give the authority on which they based their calculations. There are a great many of us who have such rules and methods of arriving at results, but we cannot really tell others how we do it. That is one of the reasons why there is a supposition on the part of some that information is being held back.

Mr. Weinshank: This is a question that has hardly a place among engineers. It is true that some manufacturers have their own thumb rules, which they have worked out from experience, and which they are anxious to keep to themselves, but I do not see why and where there should be any secrets in engineering.

At one time the blower manufacturers had tables under lock and key, which they considered sacred, but to-day any blower man will send any one any information that he may ask, even to the extent of a whole library. If any engineer, or a client, will write to any of the vacuum people that have peculiar difficulties, they will not only send you books, but will call in person and fill you full of special information.

Who is more abused than the consulting engineer? You may go into any lawyer's office or a doctor's office, and you will be asked for a retainer before any advice will be given, but you may enter any consulting engineer's office and ask him a thousand and one questions, obtain free advice and depart with a "thank you, sir." The man who is reluctant to give anything has not much to give.

TOPIC NO. 3.

"The Amount of Solid Material, Dust and Dirt Extracted by Air Washing Apparatus, per Million Cubic Feet of Air Washed."

Mr. Thomas: I would not care to make an off-hand statement as to the weight of solid matter taken out in the different cities. I haven't enough data at hand. Here in Chicago we are taking out in some buildings as much as 60 lb. in seventy-two hours on a 40,000 cu. ft. air washer on a ten-hour run. That is as close an observation as I have made as to the actual weight of material. But we have made many tests as to the proportion or percentage of solid matter taken out by washers, showing a variation from 95 to 99 per cent., and we have seen as high as 99.4 per cent.

President Bolton: How do you determine the one hundred per cent. or total solid matter, by analysis of the air?

Mr. Thomas: Yes.

President Bolton: In Chicago is the nature of that material a dust or is it carbon?

Mr. Thomas: It is carbon dust and various other things. In this locality here you will find coffee and peanut scale and various other materials that are blown out in the process of preparing food-stuffs and manufactured products. That stuff all gets into the air and finally is picked up in the ventilating apparatus, so we send it out as dirt. About half of it is carbon.

President Bolton: Can you remove within five per cent. of all the smoke that is in the air.

Mr. Thomas: No, that cannot be done. You can get about 70 per cent. of the carbon out of the contents of the smoke unless you have a device of prohibitive dimensions and excessive water supply. Then you can get a better result.

President Bolton: Can you tell us anything about the elimination of smells in these cases?

Mr. Thomas: Yes. There are very few smells that would not be dissipated by a washer. If the air is overcharged with sulphur, you will get a trace of the sulphur. That can be controlled by putting a chemical solution in the machine, containing soda ash or something of that sort. Outside of that, there is very little smell that gets through. For instance, in the stockyards: You go into Swift's office building and don't find any trace of the odor that pervades the yard. As soon as you leave the office building, you are nearly knocked over by it. And in this locality, where there are a good many different manufactories of food-stuffs, the odors are mixed in character. If you put that air through a washer you will get only a slight trace of the original odor, and for that trace you have to be on the lookout. That also can be killed by chemical solution.

President Bolton: Has any other member any other question to ask?

Mr. Natkin: There are several washers installed at the stockyards, as referred to by Mr. Thomas, and also in the Armour office building. If I recollect correctly, the washers are 40,000 cu. ft. capacity. When the apparatus was installed during the summer, some tests were made regarding the amount of dirt re-

moved. The tank is about forty sq. ft., and they remove about 2 in. of dirt from it every twelve or fourteen hours. Regular odors are almost entirely eliminated. When you enter the building there will not be any foul odor until you go out into the yard. We have no exact data of the number of pounds that have been removed. In summer, however, we have much more dirt to remove than we do in winter. It includes the dust in the air in addition to smoke and other particles.

TOPIC NO. 4.

"The So-called Superiority of Exhaust Steam Heating Over Live Steam Heating."

Professor Hoffman: This is a case wherein a general statement has been based upon local conditions. You cannot get something for nothing. If you take live steam into your engine it goes through the cylinder and does work as it passes, and comes out as exhaust steam, with less heat in it than when it went in. Now if it has less heat in it when it comes out, there is a less heating capacity, and less heating quality. I do not know that there is anything further to say.

President Bolton: It is surprising how this idea has circulated, and with what vehemence certain people continue to maintain it. In spite of the discussions that have taken place, no definite test has been advanced by any of its propounders as evidence of its truth. I am entirely in agreement with Professor Hoffman and fail to see how you can get more heat units out of exhausted than out of live steam, for, as we know, the latter has less heat in it, you certainly cannot get something for nothing.

It is, however, possible that in some particular instance the exhausted steam has been so connected into a heating system as to inject the steam into and through the system in a better manner than would take place with live steam through the reducing valve. In that way better circulation has been obtained which has led to the idea that the heating by exhaust steam is more effective than by live steam. I have seen live steam connections made to exhaust steam heating systems in such a defective way, as to place the live steam supply at a disadvantage and I am sure other members have noticed that also. Whereas the exhaust would

be led direct, the live steam is injected at right angles to the line and in some cases the reducing valve is too small, while in many cases it has to pass through tortuous passages and bends to get to the point of actual radiating work. However, I would be very glad to have any exponent of this idea give us his views and see if he can convert us.

Mr. Mackay: The statement has been made chiefly by advocates of vacuum systems of heating, that the lower the temperature of the heating medium or steam, the greater efficiency in heating can be gotten out of it. They claim that exhaust steam under vacuum conditions will go further in heating a building than live steam at a pressure.

President Bolton: It has been suggested that moisture-laden steam would have a better effect in the transmission of heat by the interior surface of a radiator than dry steam. A sectional radiator of course has only a moderate amount of interior space, but has a large extent of thin exposed surface. Moisture in the steam must gather on the interior surface and may be a better means of conveying heat than the dry superheated steam. But an assumption that this produces any greater heating effect does not seem to be justifiable, even if a fine-spun theory such as I have described should prove correct.

Mr. R. L. Gifford: Mr. President, I will rise to the defence of the vacuum people.

Now, while illogical and theoretically impossible, nevertheless, I believe that practically exhaust steam goes further than live steam. There are numerous buildings where the use of the engine as a reducing valve enables heating at a lower fuel expense than when heating with live steam, through the ordinary reducing valve. Now, I will not pretend to offer any scientific explanation, but I think the matter lies in the degree of saturation, or the relative amount of moisture, in the steam. And I believe, from an extensive observation, that low pressure steam, saturated steam, gives off a greater efficiency as to heating effect than live steam.

I remember quite a few installations in the past which proved the foregoing, for instance, one here in Chicago. The building was entirely enclosed by December, and the heating system was started, prior to the installation of the engine. The boiler plant was completed and the vacuum heating system was completed.

In firing the boilers, they cracked some of the boiler fronts, and the vacuum system was, of course, held responsible. The boiler capacity was much in excess of what the heating system would normally condense in heating that building, but the building would not heat. All we could say was, "Wait till the engine is started, and you will see the exhaust steam going to waste and the building comfortably heated." That came to pass, and was true. The proper connection for the reducing valve on the live steam is into the top of the feed-water heater, so that live steam may pick up the necessary or proper amount of moisture. It seems like getting something for nothing, but there is something in it.

President Bolton: The method of demonstrating any value in the theory which I have mentioned is to connect the return condensation into the live-steam supply line, and to let it be drawn in by suction. I have been informed that that method was to be tried in New York this heating season, in order to see if the humidifying effect of saturated steam has any beneficial effect on the transmitting capacity of the radiator. If there is anything of superior value in saturated steam, it must be that it is a better medium for conveying or dissipating heat, for there is not more but less heat in it.

Professor Allen: I think there is no question but that moist steam carries heat better than dry steam. Superheated steam is very dry and is a very poor conductor of heat. When you increase its moisture you increase its power of conduction. That is well shown in the steam engine. If you can operate any ordinary engine, so as to have dry steam come out of the exhaust, you will get less condensation on account of less heat transmission to the cylinder walls. The same effect is in radiators. If our steam is moist, we will get a much larger heat transmission to the wall than with a dry steam. That we can get any greater amount than the total amount of the heat, of course, is a question.

Mr. Hale: Some years ago, within a few blocks of this building, there was an apparatus that used low-pressure boilers for heating the building. The architect or the engineer for the architect specified that steam should be taken direct from the boilers, without a reducing valve, into the heating apparatus at five lb. pressure. There was a vacuum system attached, and it

was impossible to get satisfactory results. The steam would not carry to the far points. The company, whose apparatus was installed, insisted that a reducing valve should be used in order to remove the moisture that was being carried directly from the surface of the water into the heating mains. At their own expense they made a very careful calorimeter test of steam under both conditions. They found that on passing steam through the reducing valve, a superheated condition prevailed in the steam, and the building was heated successfully, steam being carried to the far points. On the other hand, when the reducing valve was cut out and steam at 5 lb. pressure was admitted direct from the boilers into the heating main, the percentage of moisture was so great, that the steam would not carry to the far points, and consequently it was impossible to obtain satisfactory results.

Mr. Gifford: I have frequently seen that same condition, occasioned by lifting the water out of the boiler into the mains to such an extent that the flow of steam to the far points was cut off. Some change would have to be made to balance the system and prevent the water from lifting from the boiler. In the case stated by Mr. Hale, I wonder if that could have been the condition.

Mr. Hale: Before that test was made we put a steam separator on the line and removed as far as possible the moisture that was carried up from the boiler with the steam, and that did not seem to improve conditions at all.

Professor Hoffman: In connection with Mr. Hale's statement, I wonder if that steam was not superheated after it passed through the pressure reducing valve.

Mr. Hale: That was just exactly the condition that did exist. After it passed through the reducing valve it became superheated.

Mr. Davis: I would like to add that there was 25 per cent. less fuel used under the conditions of reduced steam pressure, to say nothing of more effective heating throughout the building. When the system was run under a pressure of from 1 to 3 lb., the vacuum pumps that were installed would scarcely handle the water of condensation. They were operated by steam from a separate boiler. After the system was changed, the boiler was run at 60 lb. pressure; steam was furnished through reducing valves for heating, and one pump was ample to do the work.

Mr. Capron: I think I have some later information regarding

this same installation. Last winter I found a number of the vacuum valves turned around, and several short circuits, which evidently had been in place ever since the system was installed. If these defects had been corrected before changing the plant into high pressure, better results would have been obtained in the circulation.

Mr. Davis: That would not account for the fact that before using the reduced pressure, two pumps were required, and after the reducing pressure was used, only one pump was required.

Mr. Small: Getting back to the topic of superheated steam, or rather the use of exhaust steam vs. live steam for heating, I agree with one or two of the first remarks. The virtue is largely due to the system or the apparatus as it is originally installed. If ample radiation is provided for the building, proper boilers, proper proportion of the apparatus throughout, it is economy to use as low pressure steam as possible. In other words, we endeavor to use steam at atmospheric pressure. That is what the vacuum people all claim, that they can circulate steam at atmospheric pressure. Only a few plants are operating to-day where vacuum systems are installed at or below atmosphere. The large majority of plants carry some pressure.

In one of the American Radiator Company's little books, the Manual of Ideal Boilers, they state that extensive tests prove that the extra amount of fuel expended to furnish steam above two lb. is practically a loss. I know that a large number of gravity single-pipe systems in operation to-day are using ten or fifteen lb. of steam, which is largely due to the fact that the proper relations are not carried out. I have found that plants of that kind are very inefficient.

Now we say we can help that by putting in a vacuum system, and I think we will all agree. In other words, we can get the steam to circulate in better shape without holding up any water. When we increase the pressure up to a certain point the excess heat in the steam is available and will help. When the steam holds water in the system, then every time the air valve is opened out comes the water.

But to get back to the topic again, the use of exhaust steam vs. live steam, I want to say that one of the operating engineers of the city of Chicago told me that he had presented the problem to everybody who came into his office as to why he could

heat his building through the week-days at less cost when using exhaust steam than he could through Sunday when he was using live steam. He could not tell, he did not know, and he has never had anybody give him a satisfactory explanation of his query. It seems to me there is an element there of dead air in the building. When the building is occupied everything is moving, and I think that building will therefore heat up more readily during the week than it will on Sunday. This is somewhat analogous to the school-house heating. I have heard explanations, such as have been mentioned here, that moist steam will give up its heat or transmit its heat units much better and quicker than live steam. I have also heard the statement that the pulsations from an engine tend to atomize the steam in such a way that it will give up its heat more quickly. But I believe the main point to be considered in heating is not to have the steam too moist or too dry. A range from zero to two lb. is a reasonable pressure to carry on the mains. Now when we consider that that pressure is at the gauge on the boiler or on the heating main where it starts, due allowance must be made for some drop.

At the Steamfitters' convention here lately, one man stated that he had installed all sorts of systems, vapor and vacuum systems, and had never had a failure, and was positive that his success was due to the fact that the system was properly installed according to the instructions of the manufacturer or designer. When the job is installed on an ideal basis, with proper relations throughout, there is no reason why we should not use exhaust steam and get the highest degree of efficiency with steam circulating throughout all parts of the system.

We all have methods of figuring on our capacities of boilers, pipes, radiators and everything else we put into a job, where we design it, and much of that calculation is arbitrary. We try to follow the best authorities, but the failures in the ventilating and steam-heating systems seem to come from the fact that a man may do this or that or the other thing under certain varying conditions without understanding why. In this meeting we have had contradictory remarks owing to different views.

I do not believe we can standardize these matters, but we can arrive pretty closely to standards. The main trouble generally is due to the design of the system. If we try to apply one rule to all sorts of buildings, we are going to fall down. One of the

best things this Society can accomplish is the establishment of the best method of figuring both heating and ventilating in different forms of buildings under different conditions.

TOPIC NO. 5.

"Desirability of a Positive Supply of Air in Testing Furnaces."

Mr. Mackay: It is very desirable in testing furnaces to have a positive supply of air, but, unless it is to be used as a fan system, it does not necessarily follow that it should be an induced draft or anything of that sort. The test should be based on the natural conditions under which the furnace is used, otherwise a wrong information will obtain in regard to its capacity. You may increase the capacity of a furnace by forcing air into it with a fan, and there are many furnaces installed in buildings where, with an insufficient air supply, they do not give good results. But unless the furnace is to be used as a fan heating furnace, then the test should be made under the conditions under which the furnace is to be operated in practice.

Mr. Busey: I have had experience only with small installations with gravity systems. I use a blower and force the air through the orifices, measuring the air in the manner suggested by Professor Durley, and using his formulas. This air passes into a large chamber and the furnace takes its air supply from this source, so there is no pressure on the furnace. I run the fan just fast enough to supply the required amount of air. After a little practice I have learned how fast to run the fan and what pressures to carry in order to keep various rates of air per hour, say equivalent to 60,000 cu. ft. or whatever I want to use. I burn enough coal to give me the temperature rise that I want at the outlet of the furnace.

Dr. Colbert: As far as a constant air supply in furnace testing is concerned, I have found as the result of our experience in testing seventeen different types, and various sizes of these types, that constant air supply is an impossibility. Every furnace is a law unto itself. One type has a limited air space, tortuous and baffled, another has a passage which is relatively straight and smooth, another has a large air carrying capacity, just as free from friction as the other. Each one of those furnaces may have

the same firing capacity. We also find, under actual test conditions, that one furnace delivers air over the same area of outlet pipe at a relatively high velocity and low temperature, and that another type may have a relatively high temperature and low velocity, depending on the design. My contention is that in actual operation we should have exactly the same conditions. The minute you use a fan and induce the passage of a certain number of cubic feet of air or a certain weight of air per minute or any other unit through that furnace, immediately you lose the distinction between the various designs and immediately you place the furnace which has a small air carrying capacity and a large ratio of friction in the discharge of air in the same class in efficiency as the furnace which is constructed on more scientific and more sensible lines.

I am convinced that for ordinary gravity installation, furnaces should be tested under gravity conditions, with proper arrangement for controlling wind pressures. The only trouble we have had to overcome is the variation in wind pressure, and we had to do a little experimenting on our own hook to find out how we could prevent the periodic spinning of our anemometers as a result of sudden gusts of wind.

However, I believe that every furnace for fan work should be tested under fan pressure, and I hope later on, after we have finished our gravity testing that we may start in on this work, and put out an entirely different set of ratings of furnaces for fan furnace heating.

TOPIC NO. 6.

"The Importance of Vacuum Cleaning to the Ventilating Engineer."

Professor Allen: The city of Detroit is proposing to purchase vacuum cleaners for all the schools in that city. Before doing so they desired to make tests, and there were submitted to the committee several varieties of cleaners. I happened to be a member of thê commission that was appointed to pass on them. I shall be glad to publish the report when it is finally completed. But there are certain things obvious. In the first place, the vacuum cleaner men do not yet know what they are doing. Some of the cleaners have given vacuums all the way from 7½ to 15 in., and other varieties are nearer 2 than 15. They have vacuum

pumps that produce anywhere from 2 to 26 in. The makers have very little knowledge of the volumes required to do certain work. The weight of the machines to do the same kind of work varied all the way from 500 to 7,000 lb. The power required to do the same amount of work varied from 2 to 7 h.p. So that there seems to be no agreement as to the method that shall be pursued in getting results. The subject has not been stardardized at all.

As far as the speed of cleaning is concerned, the vacuum cleaner can never compete with the broom. We made a test in one school-room and allowed all the vacuum men to clean a room around the seats. The result was that it required from 15 to 26 min. to sweep the room with a vacuum cleaner. Then we had a janitor do the same work with a broom in less than four minutes. As far as labor is concerned, it is a little more work for the janitor to sweep with the cleaner than with the broom.

Undoubtedly there has been a great advantage in the saving of dust, and the vacuum cleaner recommends itself for introduction in school work for this reason largely.

Mr. Mackay: There are places where vacuum cleaners can be used to advantage. A member of this Society, who has a number of schools under his care, was induced by a vacuum cleaner company to examine a plant in a normal school that cost some $2,000 to install, and was considered one of their model plants. He got there and found it was not in use. The janitor told him he could clean the rooms in one-fourth the time with a broom, and they were cleaning in that way. While it may be a better process as regards dust, it does not seem to be adapted for schoolrooms with stationary seats.

President Bolton: There is much to be learned on this question of necessary degree of vacuum in cleaning processes and in the control of the vacuum. In the R. H. Macy & Company installation 8 in. of vacuum was insufficient to clean velvet pile carpets, except on the surface. The dirt was ground in by the heavy foot traffic, and could not be dislodged until the vacuum was raised to 15 in. That shows how people are feeling their way in this subject, which certainly needs more attention and more study. I am inclined to think that this Society can bring out such matters better than any other.

Dr. Colbert: I have no technical knowledge of vacuum cleaners, but I do know that they have proved very satisfactory in

modern hospitals. I do not think the fundamental trouble is with the vacuum cleaner, I think it is with the present method of school-room construction. If they followed the hospital method of curves instead of corners at the baseboard, if they followed the hospital method of having washable floors, with the desks set into the floors and the floors rounded up about the desk legs, there would be no cause for complaint. But I might say that there would be no use for vacuum cleaners except for cleaning floor coverings which could be removed from the rooms each day and taken out into the school yard and there cleaned with a vacuum cleaning apparatus. The walls and floors of a school-room, when properly constructed, should be washed down every day, and not cleaned with any vacuum cleaners.

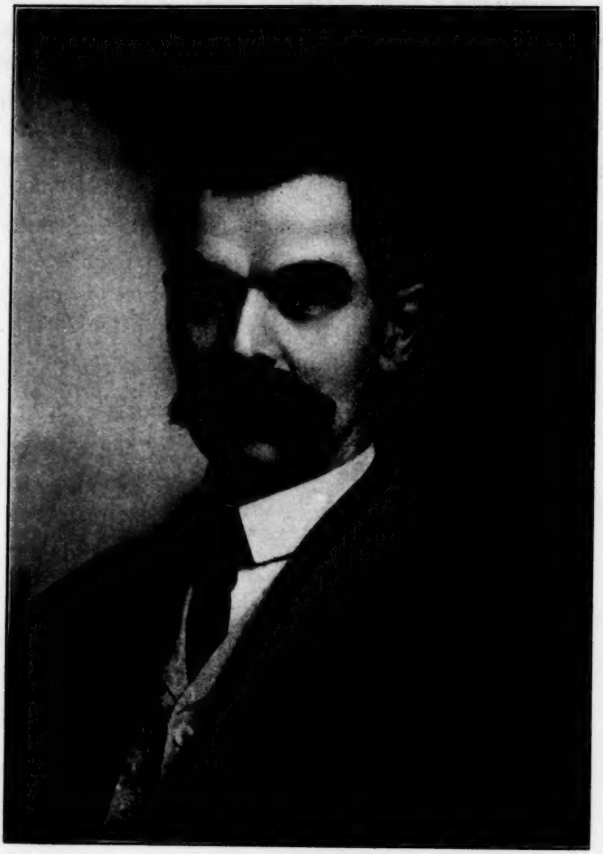
In Memoriam

	Became a Member	Died
L. H. Hart, New York	Sept. 1894,	Jan. 26, 1897.
James W. Gifford, Attleboro, Mass.	Jan. 1898,	July 26, 1899.
William McMannis, New York . .	Sept. 1894,	Jan. 19, 1901.
Charles F. Tay, San Francisco, Cal. .	Jan. 1896,	Sept. 8, 1901.
Arthur H. Fowler, Philadelphia, Pa.	Jan. 1897,	June 3, 1903.
Stephen G. Clark, New York . . .	Dec. 1902,	Feb. 3, 1904.
Charles M. Wilkes, Chicago, Ill. .	Jan. 1897,	Jan. 7, 1905.
James Curran, New York	Dec. 1901,	Oct. 27, 1905.
Herbert W. Nowell, New York . .	June 1904,	Mar. 25, 1905.
Enoch Rutzler New York, . . .	July 1901,	Feb. 29, 1908.
Harry J. Ott, Chicago, Ill. . . .	Dec. 1906,	Sept. 25, 1908.
Thomas J. Waters, Chicago, Ill. . .	Sept. 1894,	Feb. 25, 1909.
Max J. Mulhall, New York . . .	June 1909,	July 30, 1909.
Walter B. Pelton, Dorchester, Mass.	June 1910,	Nov. 2, 1910.
R. Barnard Talcott, Denver, Colo. .	June 1899,	Dec. 4, 1910.
William H. Bryan, St. Louis, Mo. .	July 1898,	Dec. 8, 1910.
James R. Wade, St. Louis, Mo. . .	Dec. 1909,	Mar. 9, 1911.
James Mackay, Chicago, Ill. . . .	Sept. 1894,	July 17, 1911.
Warren S. Johnson, Milwaukee, Wis.	Jan. 1906,	Dec. 5, 1911.

JAMES MACKAY.

On the opposite page is a reproduction of a portrait photograph of James Mackay, the first of its line of presidents whom the Society has lost by death. He was a charter member and from early times took a prominent part in its affairs. His active interest continued unflagging, and his unexpected death, resulting from a not very long illness, seemed quite untimely. Put in a few words, the Society lost by his death a remarkable personality and an indefatigable worker who had intimate knowledge of the Society's hopes and aspirations and enthusiasm for its advancement, who gave wise counsel unselfishly and cheerfully at all times, who possessed an unimpeachable character, which won the unanimous whole-souled admiration of even those merely acquainted with him. It is hoped that this appreciation in brief of his worth, the first time the Proceedings of the Society have contained a tribute of the kind, may stand as a testimonial of the esteem and affection in which he is held.

Mr. Mackay was born at Montreal, Canada, November 25, 1853. He served an apprenticeship at heating, ventilating and allied trades in his native city, after which he spent three years in Boston, Mass., then returning to Montreal to enter business on his own account. This he carried on for some years and then went to Baltimore, Md. After remaining in that city several years, he went to Charlotte, Mich., as superintendent of the Steam Heat Evaporator Company, in 1881, remaining there until 1900, when he went to Chicago as manager of the boiler department of the Richardson & Boynton Company. When that business became part of the American Boiler Company, in 1893, he continued as Chicago manager of that company and two years later became a member of the Kellogg-Mackay-Cameron Company, which took over the interests of the



JAMES MACKAY.

American Boiler Company. He served as secretary, vice-president, and sales manager of the company until his death which occurred July 18, 1911.

Mr. Mackay was a member of the Council of the Society in 1897 when the Society government was in the hands of a Council and a Board of Managers; he was a member of the Board of Governors in 1905, 1906, 1909 and 1910; he was first vice-president in 1907 and president in 1908. He was the author of a paper entitled "The Rating of Steam and Hot-Water Boilers for Heating Purposes," printed in volume VI of the Proceedings. His activity is indicated in part by the number of offices he held and by membership on committees, being for example, a member of the committee on tests in 1900, 1901, 1902 and 1903, and on the committee on standards in 1904. He was present at nearly every meeting of the Society. He was president of the Illinois Chapter for the year 1907–1908 and was a member of many business and social organizations.

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